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UNITED STATES DEPARTMENT OF AGRICULTURE

DEPARTMENT BULLETIN No. 1423

Washington, D. C. October, 1926

PROGRESS OF REINDEER GRAZING INVESTIGATIONS IN ALASKA

By

LAWRENCE J. PALMER
Biologist in Charge of Reindeer Grazing Investigations
Bureau of Biological Survey

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GROWTH OF THE REINDEER INDUSTRY

The reindeer industry in Alaska, though still in its infancy, promises with proper guidance to become an important factor in the future development of the Territory (pl. 1 and pl. 2, fig. 1). It is comparatively a recent undertaking, and as a commercial enterprise dates back only a few years. From the original stock of 1,280 animals imported from Siberia over the period of 10 years up to 1902, the reindeer in Alaska have increased to about 350,000 head, distributed in 110 herds, all but 6 of which are along the coasts of Bering Sea and the Arctic Ocean. The main grazing at present is

about four chief centers: (1) The Kotzebue Sound country, (2) Seward Peninsula, (3) about Norton Sound, and (4) in the Kuskokwim River basin.

In addition to the numbers in present herds, it is estimated that about 125,000 have been killed for food and clothing. The average gross increase per annum is between 33 and 45 per cent, and the average fawn crop runs between 50 and 60 per cent, although the better-handled herds often attain 70 per cent and sometimes as

FIG. 1.—Distribution of reindeer herds and available range in Alaska, the figures indicating the approximate number of reindeer in each section. Occupied areas are usually less than one-third stocked

much as 90 per cent. The location of herds and the distribution of reindeer and range in Alaska are shown on the accompanying map. (Fig. 1.)

Several small refrigerating plants (pl. 2, fig. 2) and two cold-storage barges were operating on the coast in 1924, and since 1918 shipments of carcasses have been made every year from Alaska to the States. The natural cold-storage facilities of Alaska have been availed of to some extent, and during the winter of 1924–25 one chamber large enough to hold 100 carcasses was excavated in the

underground ice. In areas adjoining the Arctic coast solid ice is reached within 3 or 4 feet of the surface and extends downward to great depths. In the spring of 1925 the carcasses thus stored were removed in excellent condition for shipping.

During the period 1918–1925 more than 1,875,000 pounds of reindeer was shipped from Alaska, the total for 1923 being nearly 200,000 pounds, for 1924 about 375,000 pounds, and for 1925 approximately 680,000 pounds. With continued development, there promises to be a steady increase in the output. Steers for butchering sell (1925) at $10 to $12 a head. Breeding stock is valued at $18 to $30 a head. The average cost of production for each animal is about $1 a year. At Nome and St. Michael reindeer meat retails at 15 to 20 cents a pound.

Scientific investigation of reindeer grazing by the Biological Survey were first begun in 1920, when a reindeer experiment station was established by the bureau at Unalakleet; this was subsequently (1922) moved to Nome, and in 1925 was transferred to its present location at Fairbanks. During the progress of the investigations the conditions, both as to class of livestock and their environment, have constantly developed new problems. One of the more fundamental of these has to do with the relation of lichens to grazing. Improved methods in the control and management of the herds and the range are essential to the development of a well-grounded industry. The present publication constitutes a second report on the reindeer investigations being conducted by the Biological Survey and treats particularly the forage and range management phases. The first report[1] dealt also with the biology of the reindeer and the diseases and parasites of the animals.

Plans for future work contemplate studies chiefly along the following lines: (1) The development of interior ranges; (2) conditions governing forage and range management; (3) the various relations of lichens to grazing; (4) relative carrying capacity of lichen and nonlichen ranges; (5) methods of feeding and their effects; and (6) breed improvement of reindeer and the control of the diseases and parasites to which the animals are subject. In view of the fact that conditions in Alaska are so different from those in the States as regards the kind of animal under consideration, the nature of the forage, and the climate, it is particularly important that thorough studies be made.

HERD OWNERS

In addition to the Lapps, who were brought to Alaska to care for the original stock of reindeer and to teach the Eskimos reindeer herding, and who in some cases have since acquired large herds of their own, there are three general classes of reindeer owners in the Territory: (1) Eskimos, (2) white men married to native women, and (3) other white men. The Lapp is by heritage and training a reindeer herder, but is conservative and not inclined to discontinue methods to which he has become accustomed. The white man married to an Eskimo woman differs from others of his kind, so far as

[1] Hadwen, Seymour, and Lawrence J. Palmer, REINDEER IN ALASKA. U. S. Dept. Agr. Bul. 1089, 74 pp., illus. September, 1922.

ownership of reindeer is concerned, in having the privileges of both the Eskimo and the white man. The native Eskimo rates high in intelligence, but is somewhat lacking in initiative and managerial ability. Moreover, since reindeer grazing to him is often merely of secondary consideration to hunting or fishing, as a grazier he requires constant and direct supervision. If the reindeer industry depended upon the unaided efforts of the Eskimo it would be limited in scope. To obtain the best results in range and livestock management and to perfect a desirable grazing scheme and develop the industry on a large scale calls not only for capital but for business ability of a higher order.

A recent count indicates that about a third of the reindeer are owned by white men, including several Lapps, and the remainder by Eskimos. One large incorporated company at Nome owns between 45,000 and 50,000 animals in six herds. Through this white ownership definite efforts have been made during the past few years to place the industry on a commercial basis.

REINDEER AS GRAZING ANIMALS

Reindeer on the range most closely resemble cattle, but band together more like sheep. Like horses they trample over much range in nervous feeding, but, unlike horses, usually travel against the wind. In winter they paw through the snow with the forefeet to reach lichens and other forage. During the summer they move about considerably over the range, and at times cover distances of 15 or 20 miles against the wind. In winter they graze over a comparatively small area, and remain for the most part in one general locality. At fawning time the herd divides, the does grouping by themselves and the bucks, steers, and some of the yearlings banding together elsewhere.

Reindeer become attached to their accustomed haunts, and once well located on a range will unerringly return to it if moved away. In one case, several adult animals were transferred from one herd to another over a distance of 200 miles, and the next year were found back in the original herd, in spite of the fact that there were five other herds between the two places. Unless restrained the reindeer instinctively seek successively their favorite fall, winter, or summer pastures. Such reindeer pests as mosquitoes, horseflies, and warble flies are an important factor in the choice of summer pasture, as they cause the reindeer to resort to the wind-swept areas along the coast, or the ridges and mountain tops of the interior.

Reindeer are excellent swimmers and take readily to water. In Norway it is commonly reported that herds are made to swim as far as 8 or 10 miles from the mainland to some island for summer pasturage. They graze well on the wettest ground and frequently may be seen wading out into ponds to feed on the pond vegetation. In Alaska the typical summer range of the coast is often a wet tundra of hummocky ground (niggerheads) with many ponds and sloughs, and over range of this character the reindeer graze with apparent ease. They are fleet of foot and seem to travel as readily over the niggerheads as over ground more level and firm.

B2429M

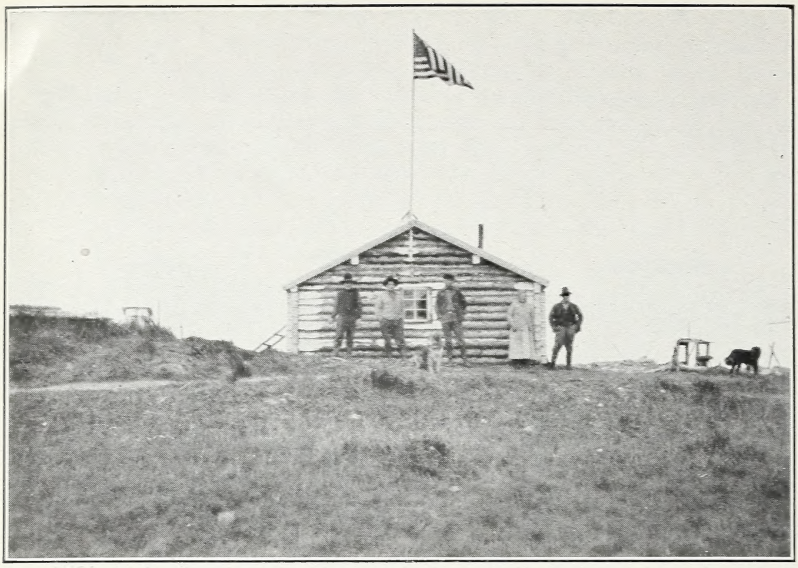
FIG. 1.—REINDEER GRAZING AT THE NORTHERNMOST POINT OF ALASKA

Part of one of the reindeer herds at Point Barrow, with the hospital and Bureau of Education buildings in the background. September, 1923

B26364

FIG. 2.—REINDEER GRAZING IN THE KUSKOKWIM SECTION

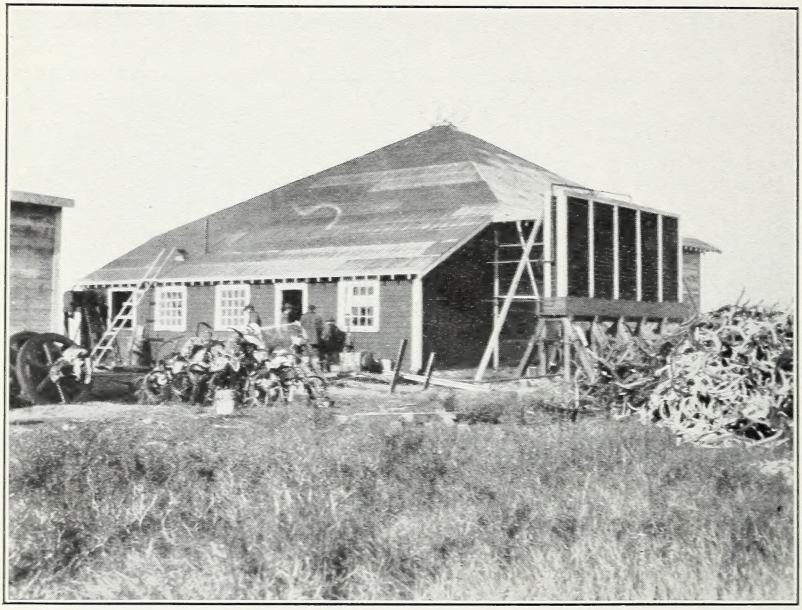
Portion of a reindeer herd at Goodnews Bay, August 1, 1922. Excellent range and fat stock



B26405

FIG. 1.—MODERN REINDEER STATION

Summer headquarters cabin of the Buckland reindeer herd on the Arctic coast



B26296

FIG. 2.—REINDEER COLD-STORAGE PLANT

The capacity of this plant, at Golovin, is 1,000 carcasses. There are now a number of these small refrigerating places along the Bering Sea coast

B28730

FIG. 1.—REINDEER TRAIN

A double team in the lead and several single reindeer strung out behind, each drawing a heavy load

B28744

FIG. 2.—SLED REINDEER

Geared with a single-tug type of reindeer harness

B20518

FIG. 3.—SLED REINDEER

Driven with a double-tug type of reindeer harness

B24350

FIG. 1.—REINDEER OF THE SHORT, STOCKY TYPE

In good winter condition. The body is short and thick and the horns flattened and irregularly shaped

B26515

FIG. 2.—REINDEER OF THE LONG, RANGY TYPE

The two adult animals in the middle foreground, in excellent summer condition, are good examples of this type, which has slender, symmetrically shaped horns

BREEDS AND TYPES OF REINDEER

In the Alaska herds there are two general types of reindeer—a long, rangy, big-framed animal and a short, stocky one (pl. 4). The longer, rangy type has finer, longer, more symmetrically branched and harder horns; the shorter has stockier, broader horns, wide at the base and often irregularly branched at the tips. The rangy type of reindeer usually averages heavier and is therefore better for the production of meat.

The average full-grown reindeer in Alaska stands 10½ to 11 hands high, and measures 5½ to 6 feet from nose to tip of tail. The maximum measurements are 12 hands high and 7 feet long. The average dressed weight is about 150 pounds and the maximum 300 pounds. The offal averages 35.1 per cent and the skin 6.4 per cent of the dressed weight, a total of about 41.5 per cent; and the meat or dressed carcass averages 58.5 per cent of the live weight.

With a view to the production of a heavier type of reindeer than at present in the herds, experiments in crossing with the large native caribou are being begun on Nunivak Island, where 10 bull caribou have been introduced into the herd of about 500 reindeer held there. Similar experiments will later be carried on at the reindeer station at Fairbanks. The 10 caribou for the Nunivak experiment were captured in the fall of 1924 at Kokrines, on the upper Yukon, where they were staked out for the winter, and the following spring were transported after many hazardous experiences by barge down the Yukon and transshipped to a schooner for the trip to Nunivak.

The numerous measurements and weights of reindeer indicate that the animals may be most profitably slaughtered at 3 years of age. The big gains in growth are made from the time of birth to this age, particularly as fawns and yearlings. A fair gain is made between the ages of 2 and 3 years, but while some is made between 3 and 4 it is so slight as to be negligible. Consequently, though not considered fully mature until the age of 4 or 5, reindeer are so nearly full-grown at 3 years that they should be slaughtered for marketing at this age rather than held for a longer period.

Observations and measurements also show a color difference depending upon the size of reindeer. The dark colors are superior to the lighter ones, and even in spotted animals reindeer of predominantly darker spots show a superiority over those of lighter shades. White animals are clearly inferior and should be promptly disposed of. The distinctly steel-gray animals, however, seem to be fully as large and strong as the dark-colored ones.

Use of the standard of excellence in Table 1 (p. 6), tentatively adopted by the Bureau of Animal Industry and the Bureau of Biological Survey, will, it is believed, be of value to reindeer breeders in the improvement of their herds.

SLED REINDEER

In Department Bulletin 1089, "Reindeer in Alaska," the present method of handling sled reindeer was described and the suggestion made that if the animals were given some form of grain with the lichens, they would endure more hardships without losing so much

TABLE 1.—*Standard of excellence for reindeer*

Points considered	Standard
I. Weight and size, according to age (*15 per cent*)	15
II. Breed-type and color (*10 per cent*):	
Representative type dark brown in summer, lighter in winter	10
III. Form, deep, broad throughout (*50 per cent*):	
(*a*) Head and neck (*10 per cent*)—	
1. Masculinity in male and femininity in female	2
2. Antlers flattened and triangular, curving upward and forward	1
3. Muzzle wide; nostrils large, wide, and open	2
4. Eyes clear and bright, indicative of quiet temperament and docile disposition	1
5. Face short; jaws strong	1
6. Forehead broad	1
7. Ears small, well covered with hair	1
8. Neck short, full, blending smoothly into shoulder	1
(*b*) Fore quarters (*10 per cent*)—	
1. Shoulders smooth, thickly fleshed, compact	3
2. Brisket wide and full, trim	2
3. Legs wide apart, straight, medium short; dewclaws large; toes spreading; hoofs large	5
(*c*) Body (*15 per cent*)—	
1. Chest full, deep, wide, large girth	5
2. Ribs long and well arched, smoothly covered	3
3. Back and loin broad, straight, deeply covered	5
4. Flank full, underline straight	2
(*d*) Hind quarters (*15 per cent*)—	
1. Hips and rump full, broad, and smooth	5
2. Thighs deep, full, muscular	5
3. Legs strong, dense, smooth boned; hoofs large; toes well spread	5
IV. Quality (*15 per cent*):	
1. Pelage heavy, fine texture	5
2. Hide pliable, medium thickness	5
3. Bone dense, smooth, strong	5
V. Condition (*10 per cent*):	
Sufficient natural flesh to indicate vigor	10
Total	100

flesh and strength. Under the crude handling now practiced the animals are neither trained nor cared for properly and the usual procedure is to drive them until they show signs of exhaustion and then to turn them loose and take fresh ones.

TYPE OF ANIMAL

In selecting reindeer to be broken to harness, attention must first be paid to type. An animal showing a docile nature, as indicated by a wide muzzle and clear, bright eyes, large, wide, and open nostrils, and a broad forehead, is the type that may be easily trained and will make the best sled reindeer.

BREAKING

The Lapps state that with a few tame animals to lead they can sufficiently break a string of 10 or 15 reindeer in two or three days to make a trip with each animal pulling 100 pounds on a sled. But great care and patience must be taken in the process not to frighten or injure the animals. With gentle handling, they learn quickly

and are easily broken to drive. On a trip, the Lapps drive a double team ahead and lead a long string of single reindeer behind, each pulling a sled. (Pl. 3, fig. 1.) Ordinarily reindeer work better in company, and double driving is preferable to single.

In experiments with a sled reindeer conducted while the reindeer experiment station was at Nome, training was begun by haltering the animal and permitting it to drag a rope about the barn inclosure for a couple of days. Then each day for three or four days the haltered animal was coaxed to lead a little. Finally it was harnessed, gently but firmly, and hitched with a second trained reindeer to a sled and driven 2 or 3 miles. It was then returned to the barn, with the harness left on over night. The next morning the harness was removed; two days later the animal was again harnessed, hitched to a sled, and driven behind a trained sled reindeer about 4 miles. To make the start, the animal had to be led by the halter a short distance until it would follow the other sled reindeer, and then it was off at a run. After a few sudden stops and starts, it finally settled down and pulled its sled willingly. The next day it was hitched to a loaded sled and successfully driven double for a while, and then single for about 10 miles; thereafter the reindeer was steadily worked for a period with entire satisfaction.

HARNESS

Two types of harness are used in driving sled reindeer, one with a single pulling tug fastened under the chest and running between the hind legs, and the other with two tugs and a singletree, as used with a horse or dog (pl. 3, figs. 2 and 3). In the first case the tug is usually made of a strip of reindeer skin, since this is less apt to chafe the legs of the animal. Both kinds of harness are satisfactory. A wooden collar is used, made in two pieces to fit around the neck, the ends fastened together by thongs. To this collar are fastened the side-straps leading to a body-band, which encircles the animal just back of the forelegs. When the singletree is used, the tugs, one on each side, are fastened to the body-band and are continuations of the straps leading from the collar. In the single-tug type, the tug is fastened to the harness and to the sled by means of a wooden toggle inserted into a loop.

For guiding sled reindeer two driving lines attached to the halter are used. The animal is started by flipping one of the lines across the back and over the root of the tail, and is guided to the right or left by jerking one line or the other.

WORK ABILITY

To determine the value of feeding grain in the use of sled reindeer, a cross-country trip of 527 miles was made over a period of 42 days, 23 of which were spent in actual travel. In addition to the lichen roughage, grain was fed regularly during the entire period. For comparison, a dog team also was driven on the trip, and it was found that as a draft animal a reindeer performs the work of about three dogs.

The sled reindeer made the trip very successfully, and demonstrated that when fed grain to keep up strength, they may be worked steadily

and driven over long distances. The average distance covered was 23 miles a day, and the maximum, on a fair trail with a load, was 35 miles, whereas on a poor trail it was 20. With an empty sled and carrying only the driver, the daily average would undoubtedly be greater.

The maximum load for a sled reindeer for continuous travel and on grain was 250 to 300 pounds on a good trail and 100 to 150 pounds on a poor one. With the driver riding half the time, on an average trail a full load for each sled reindeer was 100 to 150 pounds, aside from the driver.

FEEDING

During the 42-day experiment the sled reindeer was fed 170 pounds of grain at the rate of 4 pounds a day. Rolled oats were fed morning, noon, and night, the main feeding being at night. Lichens were gathered each day en route just before going into camp, a simple matter toward the end of the day, so that the animal could be fed in camp rather than staked out. By keeping the animal in camp, it could be cared for more conveniently. The practice was also followed, when passing through sections of little moss, of carrying half a sack of it on the sled for occasional feeding en route, especially at noon. On the trail it was necessary to stop the animal three or four times during the day, including the noon stop, to give it a bite of reindeer moss. When passing through country of good lichen growth the animal would pick its own food along the trail, so that it was unnecessary to carry a supply. The reindeer consumed two sacks of the lichens (reindeer moss) daily—about 20 to 30 pounds, air-dry weight. (The wet weight is usually three times the air-dry weight.) It displayed an enormous appetite and consumed about twice as much roughage a day as one would when fed in a barn and not worked.

When hungry, the sled reindeer ate all the lichens offered, irrespective of species, and took also some of the sedge and browse forage, especially Labrador tea, cranberry, and willows. When the first sharp edge of hunger had been allayed, it fed choicely on the lichens only, seeking as much variety as possible. It seemed especially fond of *Cetraria cucullata* and of all light-colored forms of *Cladonia*. When fed grain at night or noon, the reindeer would eat first a few oats and then abandon these for lichens. When fully satisfied on the lichen roughage, it would return and eat a full ration of oats.

USE OF SLED REINDEER

The use of sled reindeer is not so common in Alaska as it should be under proper handling of the herds. The dog team is better suited for main trails and coast travel, but for cross-country travel and for use with the herd, the sled reindeer is cheaper and more practical. For each thousand animals in the herd there should be at least 10 well-trained sled reindeer. They can be used effectively in traveling over the range, hauling supplies to camps, following up the herd or making drives, and in corralling. As they feed on the open range, it is not necessary to carry feed for them, except a small quantity of grain when on long trips or when used continuously. Aside from

this, the presence of several tame sled reindeer in the herd is of greater value in the better domestication of the herd than is commonly supposed.

REINDEER MEAT

Many persons still seem to be under the impression that the reindeer is a game animal and that the meat is venison. This is not the case. The reindeer has been developed from the wild caribou of northern Europe and Asia through countless generations of breeding, and as the breeding up has been without particular direction, the present type is perhaps not far removed from the original. There is some difference, however, in conformation and general coloration [2] between reindeer of Siberian descent and the caribou of Alaska and Canada, and considerable difference in the temperament of the animals and in range habits.

Reindeer meat, when properly produced and handled, compares favorably with beef. It is fine grained, contains a good, palatable fat, and when fresh is exceptionally juicy and tender. C. F. Langworthy, of the Bureau of Home Economics, comments upon reindeer meat as a food, in a memorandum to the Biological Survey, as follows:

> Many studies have been made of the composition of different sorts of meat, of cooking qualities, and of thoroughness of digestion. Judging by available data, meat from different animals used as food is very similar in its general composition.
>
> Besides the considerable amount of water present, meats contain protein or nitrogenous material, fats in varying amounts, minute proportions of glycogen or animal sugar, and some ash constituents. The percentage of fat varies very greatly with feed and other matters.
>
> Some cuts are considered better flavored and some more tender than others, but, generally speaking, meats of different kinds and cuts are very similar in their food value and digestibility, meat protein like other complete protein being used for the building and repair of body tissue, and the fat of meat, like other fats, as body fuel. This applies in a general way to game also.
>
> To understand the place of meats (including reindeer meat) and other foods in the diet, one should remember that in order to be well balanced the diet, week in and week out, should provide: (1) Vegetables and fruit, valuable for ash and vitamin constituents; (2) meat, milk, eggs, fish, and other foods that supply "complete" protein; (3) cereal grains and their products, as sources of carbohydrate for energy or body fuel; (4) sugar and other sweets, as flavor foods and sources of body fuel; and (5) fat, as a source of body fuel, which in some cases, as in butter and cream, is accompanied by vitamin. Reindeer meat is well fitted to take its place with other meats.
>
> Reindeer have been bred for food purposes for centuries in northern Asia, which is clear indication of their fitness for food. The flavor is excellent, the food value compares well with other meats, and the meat is wholesome and can be prepared for the table in a variety of ways.

FEEDING EXPERIMENTS

FEEDING PREFERENCES OF REINDEER

Reindeer are herbivorous and ruminant animals, feeding chiefly on sedges, grasses, and browse plants in summer and on lichens in winter. They are known at times also to eat mice, dried fish, and ptarmigans and their eggs, a habit that probably may be attributed to a craving for certain mineral substances. The value of the differ-

[2] U. S. Dept. Agr. Bul. 1089, pp. 9 and 10.

ent kinds of range forage plants grazed varies greatly with the stage of growth, and probably to some extent with the tastes of individual animals. As a rule reindeer prefer a variety of green and fresh growths. In spring they seek the earliest vegetation, and feed on green growth throughout the summer. In fall and winter they feed on lichens and grasses and on dry vegetation of various kinds. They prefer, however, the lichens known as reindeer moss which have made new growth and attained greater moisture in fall and consequently are fresher and probably more palatable. Though the lichens represent principally the winter forage of reindeer, they are taken also in summer to the extent of about 15 per cent of their food.

TESTS WITH CULTIVATED GRAINS AND GRASSES

Reindeer are fattest in fall, following the summer grazing on green feed, and during the winter months gradually lose in condition on the lichen feed. It has been commonly stated or supposed that reindeer fatten on the lichen forage and that it is necessary for their maintenance; but feeding experiments have demonstrated that this is not the case, and that reindeer can be fed and fattened on cultivated growth as well as can other classes of livestock. Under experimental winter feeding reindeer have been successfully weaned from a lichen diet and fed on hay and grain. In experiments conducted under the direction of the writer the animals were kept under shelter and handled much as are domestic cattle. The feeds used were timothy, alfalfa, native hay, linseed meal, rolled oats, and chopped corn feed, which included cracked corn, rolled oats, and rolled barley. Check animals were fed on a full ration of mixed lichens and native hay.

It took about 7 days to wean the younger stock from a lichen feed and to get them to eat hay and grain readily, and about twice as long to wean the adult stock fully from the lichen diet. On a lichen ration the check animal ate 10 to 15 pounds of lichens (air-dry weight) and 2 pounds of native hay a day; and on hay and grain the individual reindeer consumed about 4 pounds of hay (alfalfa or timothy) and 4 pounds of grain a day. To make the change from lichens to hay and grain, a mixture of lichens and grain or of lichens and hay was first fed and the quantity of lichens gradually reduced until entirely eliminated.

In experiments in feeding 10 yearling and 2-year-old caribou bulls during a 23-day journey from Kokrines to Nunivak Island, the animals with no lichens supplied took readily to a hay-and-grain diet in three or four days. Each one was fed about 7 pounds of hay and 4.5 pounds of grain daily, but as they consume only the leaves and finer parts, the actual hay eaten by each did not exceed 5 pounds.

IMPORTANCE OF LICHEN FORAGE

In 60 and 90 day station tests on hay and grain the animals made gains of two or three times that of check animals on lichens, varying from half to two-thirds of a pound a day. The check animal made a slight daily gain. Under range conditions, however, reindeer will generally hold their own on a lichen feed and make slight gains where sheltered and where plenty of feed is to be easily obtained, but they lose in condition if unsheltered and forced to rustle extensively for their food.

Lichens are not necessary for reindeer feeding because of any natural or nutritive qualities; but, because they present a readily accessible winter forage, they are the chief factor that makes reindeer grazing possible in Alaska. Without this ready source of food for winter use the reindeer could not be maintained on the coast range successfully, and, consequently, the industry would not exist. The lichen forage crop in Alaska should therefore be carefully guarded in order to continue the yield.

EFFECT ON QUALITY OF MEAT

Feeding reindeer on cultivated crops has an important effect on the meat. An animal fed on alfalfa hay and grain (rolled oats and cracked corn) was slaughtered when fat and the meat tested. As compared with range stock, the meat from this reindeer proved firmer, finer grained, and drier, and the fat generally occurred scattered through the meat rather than being localized. The texture and quality of reindeer meat apparently is affected by the kind of food eaten, and probably varies directly with the quality.

ANALYSIS OF FEEDS

Table 2 (p. 12) shows the analysis of lichens and other range plants and cultivated crops. Generally, in comparison with range and field crops, the lichens show a lower percentage of protein and a higher percentage of starch.

Of the lichens listed in Table 2, those of forage value in Alaska, in the order of their importance, are *Cladonia*, *Cetraria*, and *Stereocaulon*. The species of *Parmelia* are of little economic value because of their scattering occurrence and inferior size. When this is taken into consideration, the difference in protein content of the lichens, as compared with other feeds, is found to be even greater.

NATURE OF GRAZING USE

The nature of the reindeer industry in Alaska was described in detail in Department Bulletin 1089. As bearing directly on the problem of proper range management, however, it may be well to outline briefly the nature of the grazing use in Alaska in order to incorporate information which has resulted from later studies and observations.

No cultivated forage crops are raised and no feeding is done in connection with reindeer grazing in Alaska. The animals are grazed yearlong on the open range, and from six to six and a half months of this they are on winter forage. Each herd is confined to an individual area, which is a piece of range usually fairly well defined within a natural topographic unit. Major features of topography, as large streams and main ridges, divide the various grazing areas. Each unit includes summer and winter ranges and fawning grounds, and each has its own buildings, corrals, and other improvements necessary for the individual herd. (See map, fig. 1, page 2.)

Unlike much of the reindeer grazing conducted by the Lapps in northern Sweden and Norway, where a nomadic existence is common, reindeer grazing in Alaska is more centralized and tends toward permanent ranches. This difference is largely due to the abundance

TABLE 2.—*Analysis of food value of lichens, other forage plants, and cultivated grains and grasses*[1]

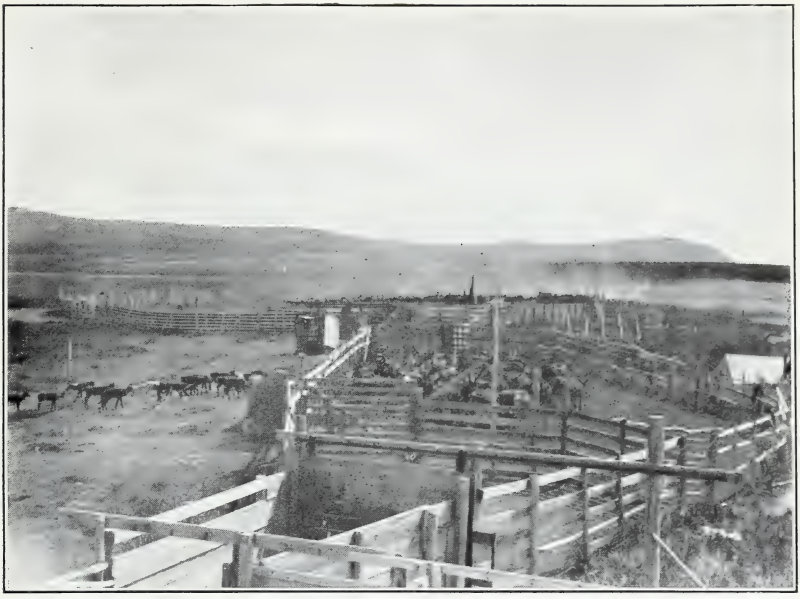
Species	Moisture	Ash	Fat	Protein	Starch	Cellulose
Lichens:	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Cetraria islandica	14.50	1.15	2.10	2.80	74.90	4.55
Cetraria nivalis	15.00	1.40	3.55	1.60	76.00	2.45
Cladonia rangiferina	15.00	.90	2.15	2.05	49.40	30.50
Stereocaulon paschale	15.00	1.85	1.75	6.35	56.60	18.45
Parmelia ahrausta	15.00	8.05	2.25	6.10	51.25	17.35
Parmelia saxatilis	15.00	10.70	14.75	5.20	47.15	7.10
Average	14.92	4.01	4.42	4.08	59.22	13.40
Browse:						
Salix hastata	15.00	4.40	3.00	14.80	51.10	11.70
Salix lapponicum	15.00	3.60	2.65	14.00	47.00	17.75
Salix glauca	15.00	5.50	4.00	12.85	47.75	14.90
Salix herbacea	15.00	3.85	2.75	14.85	47.30	16.25
Average	15.00	4.34	3.10	14.12	48.29	15.15
Grasses:						
Poa alpina	15.00	3.90	2.30	11.60	41.85	25.35
Aira flexuosa montana	15.00	4.70	2.80	10.15	44.00	23.35
Average	15.00	4.30	2.55	10.88	42.92	24.35
Grains:						
Corn	11.30	1.40	5.00	10.50	70.10	1.70
Barley	10.90	2.40	1.80	12.40	69.80	2.70
Oats	11.00	3.00	5.00	11.80	59.70	9.50
Average	11.07	2.27	3.93	11.57	66.53	4.63
Meal:						
Cottonseed meal	8.20	7.20	13.10	42.30	23.60	5.60
Linseed meal	9.20	5.70	7.90	32.90	35.40	8.90
Oat meal	7.90	2.00	7.10	14.70	67.40	.90
Average	8.43	4.97	9.37	29.97	42.13	5.13
Hay:						
Timothy	13.26	4.49	2.50	5.90	45.00	29.00
Alfalfa	8.40	7.40	2.20	14.30	42.70	25.00
Average	10.80	5.90	2.35	10.10	43.85	27.00

[1] The analysis of lichens, grasses, and browse for this table was obtained from a translation of the Norwegian "Report of Grazing Committee on the Use of the Harang Section—Lands Department" (Indstilling fra Fjeldbeitekomiteen om Hardangerviddens utnyttelse—Landbruksdepartementet). Kristiania (Oslo), 1911. The comparable figures for grains, meal, and hay were obtained from "Profitable Stock Feeding," by H. R. Smith, 1913.

of forage in Alaska and to the presence of large natural grazing areas capable of being divided into individual grazing allotments, each complete in itself. The nomadic habit of the Lapp requires that he handle his reindeer under a close-herding practice; but in Alaska, to obtain the best results under a fixed-allotment system, open herding must be practiced.

SIZE OF HERDS

The reindeer are now run in herds of from less than 400 up to 8,000 head, and in one case 12,000, with the average about 2,500. Because of the large natural grazing units, the impracticability of dividing the range among numerous small herds, and the fact that reindeer on the range are not so amenable to control as are sheep but must be handled more like cattle, the future tendency will be toward the larger herds. The number of animals to which each herd may increase is limited by the carrying capacity of the individual allotment. The size of an allotment is governed, of course, by its natural



B28732

FIG. 1.—IMPROVED REINDEER CORRAL

A herd of about 5,000 animals is being driven into the main corral of the Golovin herd. The pen in the background is for holding stock cut out for butchering

B26306

FIG. 2.—REINDEER ROUND-UP

The herders at Pastolik are preparing to cut off and drive a bunch of reindeer into the pens leading to the chute. The animals are still in winter coat, July 4, 1922

97189°—26——3

B28790

FIG. 1.—HANDLING REINDEER AT END OF CORRAL CHUTE

Each one is caught by the horns, passed through the gate at the end of the chute, and thrown to the ground for marking or castration

B26460

FIG. 2.—THROWING A YEARLING REINDEER

The animal is grasped by the horns and thrown by twisting the head

B26443

FIG. 1.—BRANDING REINDEER

Branding with a hot iron, usually on the flank, when carefully performed has proved sufficiently satisfactory to warrant adoption

B26710

FIG. 2.—A SUCCESSFUL BRAND

A broken circle brand on the left flank one year after branding. Branding with a hot iron is now being practiced in six of the Alaskan herds

B28778

FIG. 1.—PERMANENT CABIN CAMP

Herding cabins, especially on winter range, are preferable to tents. Several of these camps variously located over the range are needed on every growing allotment

B25741

FIG. 2.—TEMPORARY TENT CAMP

Tents are resorted to by the reindeer herders when cabins are not provided. They serve solely as temperary shelter and are not so satisfactory as cabins

boundaries, but most of the units will have a carrying capacity of 5,000 to 10,000 reindeer. Accordingly, the future herds in Alaska will run from 5,000 to 10,000 heads, or an average of 7,500.

Large grazing allotments will make possible the establishment of cooperative herds among numerous small owners, and this will result in the formation of many cooperative reindeer associations, or livestock companies, especially among the Eskimos.

HERDING

Reindeer are now herded almost entirely on foot, mainly by natives and Lapps, commonly aided by dogs. One or two herders go out each day from a central camp to watch the herd, sometimes remaining out over night. Horses for herding are employed to some extent in the interior but have yet to be tried along the coast. Sled reindeer and dog teams are used during the winter for hauling camp supplies; in summer, transportation is largely by boat and on foot.

ROUND-UPS

The herds are rounded up for marking or branding and castration early in summer, usually in July. Again, in fall and early in winter—October, November, and December—they are rounded up for butchering. During the middle of the winter another round-up may take place for separating mixed herds or breeding and nonbreeding stock. All handling was formerly done by roping on the open range or in a crude brush corral. Now, however, the corral and chute method has come into more general use, and roping is being abandoned (pl. 5).

CORRALS

Two methods of corralling are employed, one using the chute, the other the pen. For efficient work with the chute a large force of men is necessary, whereas the pen has the advantage of requiring only a small crew. When the chute is used, all the animals are driven through and caught at the end (pl. 6). When the pen is used, the animals are handled in a central working pen and those to be marked or otherwise handled are captured by means of sheep hooks.

A diagram of a corral of the pen type successfully in use at Kokrines, Alaska, is shown in Figure 2. With this corral a crew of five men has marked reindeer fawns at the rate of 750 a day. A highly successful type of corral of the chute method, and the type most commonly used, is shown in Figure 3. With a crew of 15 men, reindeer may be handled in a corral of this kind at the rate of 125 to 175 an hour.

In erecting the type of corral shown in Figure 3, it is very important to construct the entrance hook leading to the holding pens and chute on the side of the corral meeting the direction of mill. This may be either to the right or to the left depending upon the individual herd. One herd will not mill both ways, always going either clockwise, or counterclockwise. It is therefore necessary to note the direction of mill in order so to construct the entrance hook as to intercept the milling animals and facilitate their capture. Two

hooks, one on each side of the corral, may, of course, be constructed, but only one is needed if the direction of milling be known. It is easy to drive the reindeer into a hook properly placed, but difficult to drive them into a hook not opening toward direction of the mill. Of 25 herds observed in respect to milling, 3 were found always to mill counterclockwise and the remainder clockwise.

HOLDING PASTURE

A recent improvement for handling reindeer when the corral is used at round-up time is a holding pasture adjoining the corral. As the Alaska herds increase in size the use of a holding pasture will become more and more necessary. It not only insures convenient holding of the herd at the round-up but makes it more possible to handle a large herd at one time without starving the animals. The main herd is confined in the pasture on feed and water, and, from time to time as needed, bunches are cut out and driven into the

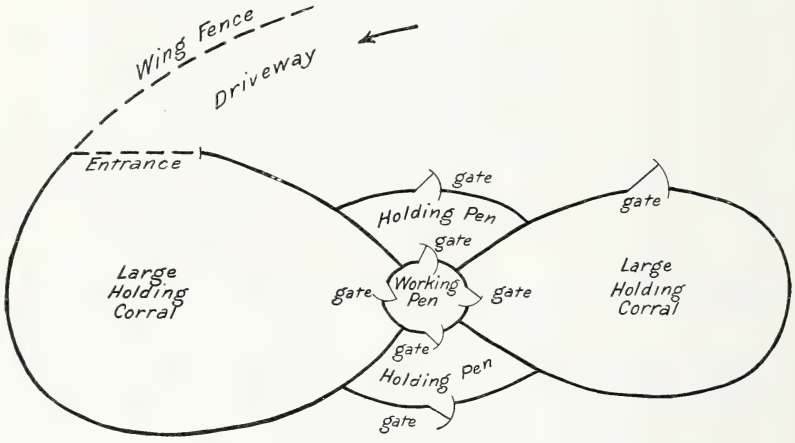


FIG. 2.—Diagram of corral of the pen type successfully used at Kokrines, Alaska. The reindeer are handled in the working pen and the fawns are caught by use of sheep hooks

corral for handling. Thus, except for the relatively brief time when they are being put through the corral, the reindeer are abundantly provided with feed and water in the holding pasture during the round-up period.

BRANDING

Reindeer are mostly marked by cutting off the tip of one ear or notching one or both of them. Some herd owners have used a metal ear tag or button in addition to cutting, but this kind of marking is being abandoned as unsatisfactory. Because of the numerous marks required to distinguish the many small owners, ear marking also has its limitations. Consequently, the organization of cooperative herds under one mark or brand is now being urged, and branding with a hot iron supplemental to ear marking is being considered. Experimental branding has been conducted in several herds and where carefully performed has proved sufficiently satisfactory to

warrant adoption (pl. 7). Branding, usually on the flank, is now being initiated and will undoubtedly become a more general method. A brand law for Alaska recently adopted provides for the marking or branding of reindeer and the registration of the brand or mark.

NATURE OF THE RANGE

RANGE BELTS

There are three distinct range belts of different uses: (1) The immediate coast region, including the islands; (2) the far-interior country; and (3) an intermediate region, which may be termed the inland-coast or coastal-valley belt. In the coast region,

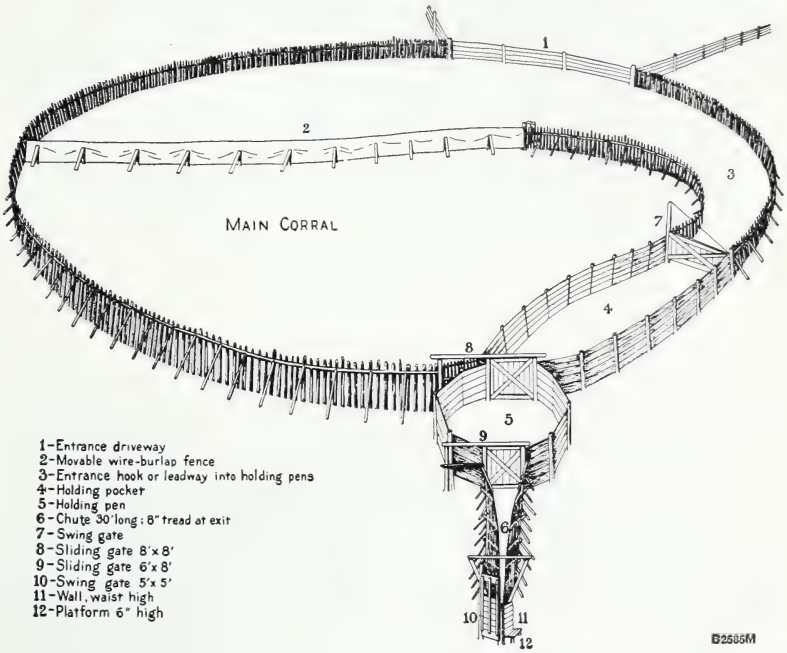


FIG. 3.—Highly successful corral of the chute type. It is important that the leadway into the holding pens be constructed on the side of the corral to meet the direction in which the herd mills. The movable wire-burlap fence is very useful in cutting off bunches of stock from the main herd

the summer range of mostly tundra flats lies immediately along the coast, and the winter range lies inland on the coast uplands of hills and mountains. In the far interior the grazing lands are in the mountains, and the reindeer usually summer on the mountain tops and winter either on adjoining protected and favorably exposed areas or on lower ground near timber line. In the intermediate, coastal-valley belt, as in the Kuskokwim, Yukon, and Kobuk River Valleys, the reindeer may summer either along the valley flats and bench lands or on the mountain tops, and winter in the middle, usually timbered, zone between the upper and lower elevations.

The chief factors determining the seasonal range areas are (1) forage, (2) exposure, (3) the fly pest, (4) the physical character of

the range, including topography and tree growth, and (5) accessibility. The relation of summer to winter range must also be carefully considered. Availability of lichen forage for winter use is most important, since the successful continuation of reindeer grazing is dependent upon a sufficient winter food supply.

RANGE TYPES

The physical nature of the land and soil varies considerably, producing three main types of range: (1) The dry tundra; (2) the wet tundra; and (3) the rocky areas. In terms of relative carrying capacity, both as to forage content and nature of ground, these type areas vary appreciably. The dry-tundra and the wet-tundra ranges may run about equally high in average forage production, but soft or marshy ground reduces the actual carrying capacity because of the greater harm done to the forage plants when trampled into the wet earth. The rocky type usually has a lower carrying capacity than the other two because of the reduced forage growth (pl. 9; pl. 10, fig. 1).

The coast range bordering Norton Sound and southward, including the lower sections of the Yukon and Kuskokwim, consists largely of the wet-tundra type. Northward the character of range improves and the dry tundra begins to prevail; and north of the Noatak River and up toward Kivalina and Hope the rocky type of range is predominant, intermingled with the dry-tundra areas. Goodnews Bay, in the Kuskokwim region; the interior areas; and Nunivak Island are largely of the dry-tundra type. St. Lawrence Island is mostly the rocky type, with immediate beach areas of wet tundra.

TIMBER RANGE

The general presence or absence of trees furnishes another classification of range (pl. 11, fig 2). About 50 per cent of the Territory is forested to some extent. Excluding southeastern Alaska, the forest areas lie chiefly on the interior ranges over the central portion of the Territory. The importance of the presence or absence of trees on the range lies particularly in offering shelter to the herd and the herder and in providing fuel and ready material for the construction of cabins, corrals, and fences. In many sections of the country it is not difficult to construct necessary range improvements or establish camps; but where there are no trees, as over the major portion of Seward Peninsula and along the Arctic coast, the problem of construction material and fuel for camp use is serious, especially on winter ranges. Thickets of tall willows along rivers and creeks are often a saving factor, and lignite in a number of places provides a convenient fuel. Along the immediate coast, beach driftwood is an important source of fuel and building material, and in the Wainwright and Barrow sections, cakes of ice are sometimes employed in the construction of temporary corrals in winter.

RANGE SITE

Range site or location with reference to transportation facilities, or to mining camps and villages, is also an important consideration both as regards ready access to men, supplies, and equipment and the convenient shipment and marketing of meat. This item accounts

FIG 1.—WET TUNDRA RANGE

The forage cover consists chiefly of sedges, browse, and lichens

FIG. 2.—ROCKY TYPE OF RANGE

Almost barren and of little or no use for grazing

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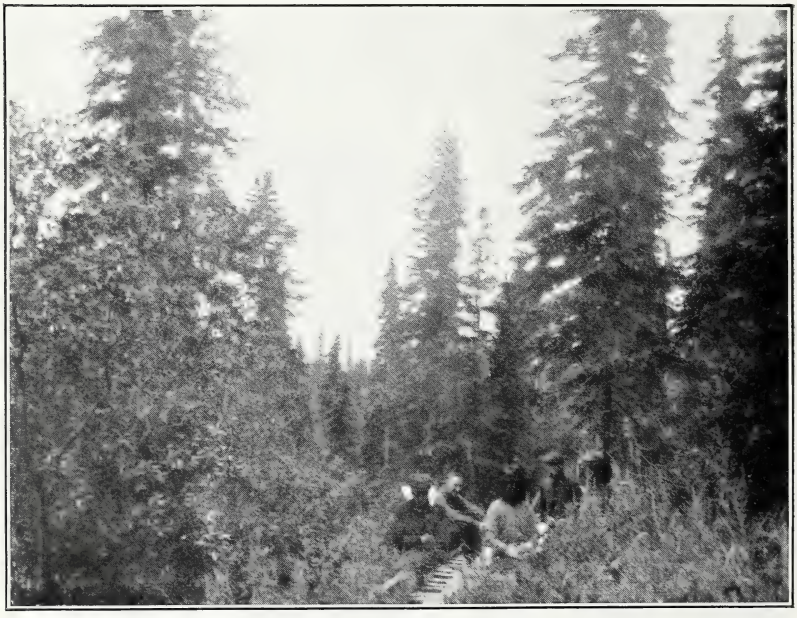
B26501

FIG. 1.—DRY-TUNDRA RANGE

Forage cover of browse, weeds, sedges, and grasses. Willows heavily grazed by reindeer; foliage stripped



B26462

FIG. 2.—TIMBER RANGE

A luxuriant undergrowth of grasses, weeds, and browse near Kobuk River, above the Arctic Circle

chiefly for the fact that most of the Alaskan herds are at present on or near the coast, with the greatest concentration at the most accessible points. With greater opening of transportation facilities into the interior, more herds will be established away from the coast. Accessibility within the individual range area also affects the problem in that the most conveniently accessible unit or allotment offers the easiest management and promotes greater efficiency later on in putting a range management scheme into effect.

SALTING

In the interior little or no salt is available for the grazing reindeer, and salting the range is highly important both for the best condition of the individual animal and for proper range control. Reindeer are fond of salt, and when held along the coast they get it during the summer by drinking sea water or licking up saline deposits on the beach. This undoubtedly is as important a factor as the fly pest in urging the animals to the coast during the summer months. Under present conditions, salting the range is not a problem on the coast areas, but upon greater stocking and closer utilization it will become an important consideration.

Reindeer take readily to block or rock salt, and the use of this on the range is preferable to that of crushed salt. If crushed salt is used, there is danger that the animal will eat too much and become poisoned. Losses from such poisoning have been reported. The use of rock salt, however, is not dangerous, and for handling on the range, this form is more convenient and economical.

RANGE IMPROVEMENTS

Fencing on the range is yet a minor factor, but in some instances it is now employed for pasture purposes as an adjunct to the summer corral at round-up time. Boundary fences, or short drift fences at strategic places on the range are considered practicable and will undoubtedly be constructed soon on many allotments.

Two or more herding cabins are usually constructed on each grazing allotment. In addition, temporary camps are often made at various places over the range convenient for herding. To facilitate handling the herd, 4 or 5 and in one case even 13 cabin camps have been established over the range. The permanent cabin camps are preferable to the temporary tent camps and they are being more generally constructed (pl. 8).

INFLUENCE OF CLIMATE ON REINDEER GRAZING

A RANGE FACTOR

Climatic conditions have an important effect on reindeer grazing, both as regards the animal and the range and forage. The natural habitat of reindeer is the arctic and subarctic regions, and the animals undoubtedly do best on ranges falling within these climatic zones. Although reindeer are generally adapted to severe climatic conditions, there may be situations that must be considered in which the animals are at a considerable disadvantage. Because of winter

rains certain areas near the coast are subject to periodic crustings of snow, and in such places herds may suffer great losses through starvation, since the animals can not paw through the hard crust to get feed. In case of crusting, the herd must be promptly moved back to protected areas in the interior hills.

Under ordinary conditions the depth of snow on the winter range along the coast does not seriously affect grazing, since part of the area at least is generally exposed to the winds and does not become deeply covered. In the interior, however, particularly on timbered flats and bench-land country, there is less drifting, and the depth of snow then affects the selection of winter range. Where considerable drifting takes place, certain areas may become so deeply covered that the animals can not paw through the snow to reach the vegetation. Ordinarily, to reach the lichen forage reindeer will readily paw through as much as 2 feet of packed snow and 3 feet or more of loose snow.

A FORAGE FACTOR

The effect of climate on plant growth is an important factor in reindeer grazing, especially as regards the lichen vegetation. Lichens attain their maximum development and number in tropical regions. The proportion of cryptogamic to phanerogamic vegetation increases, however, from the Equator to the poles; thus in Alaska the proportion of lichens to other vegetation is relatively high. Furthermore, the numerous species of lichens vary in their climatic requirements, so that the predominating species in Alaska are determined by a preference for the arctic and subarctic habitat; and within the habitat the varied local climatic conditions show a marked effect on the character and development of the growth.

Moisture is a most potent agent in the development of the lichen, but an excess of moisture seems prejudicial to lichen development, in that it produces a sterile state of the thallus and favors the production of pulverulent and dwarfed forms. Season and vicissitudes of climate may variously affect the lichen growth, in some species causing changes in chemical composition and in others altering the form of the thallus, since under abnormal conditions the gonidal element of the thallus may become productive and give rise to various malformations.

LOCAL VARIATIONS

There is often considerable variation in climatic conditions between localities, chiefly on account of topography. One locality may be particularly subject to frequent and severe storms, whereas much more moderate conditions simultaneously exist in immediately adjoining areas. Again, in the general coast region there may be great variation in winter temperature as between the immediate coast and the interior; over a distance of 40 miles the difference may be as much as 20° F., the lower temperature occurring inland. Considerable difference between localities is also shown in the beginning of plant growth in spring. For example, in 1922, the growing season at Unalakleet opened four or five days earlier than at St. Michael, only 40 miles south; two weeks earlier than at Pastolik, 100 miles south; and two to three weeks earlier than at Nome, 150 miles north.

As to general conditions, the climate is considered more moderate in the Kuskokwim River valley to the south, and in the Kobuk River valley above the Arctic Circle, than in the regions lying between. Much lower winter temperatures prevail in the far interior areas than in the coast belt, but the higher winter temperatures of the coast region are offset by the greater humidity and prevalence of wind.

SEASONAL VARIATIONS

Seasonal variations also have an imporant bearing on reindeer grazing. The summer forage crop may be greatly decreased by a backward season or increased by favorable conditions. Thus there are poor feeding seasons and there are good ones, each in turn being clearly reflected in the condition of the grazing animal. Variation in the advances of the spring season is a problem at fawning time. Under very late conditions greater care must be taken for the protection of the newborn fawns, which often come very early in Alaska. Although reindeer fawns are remarkably hardy and capable of withstanding the ordinary vicissitudes of climate, yet extreme conditions sometimes result in heavy losses unless precautions are taken.

Perhaps most important of all is the effect that the varied seasons have on the fly pest and consequently on the reindeer. During a prevailing cloudy and rainy season, as experienced in 1922, the number of warble flies is greatly reduced and in some sections they may almost disappear. Under such conditions the reindeer are able to graze unmolested.

SOIL CONDITIONS IN ALASKA

Soil conditions are an important consideration in the selection of a range, chiefly as influencing plant growth, especially lichens. Within the three main ground types—dry tundra, wet tundra, and rocky areas—are various kinds of soils, the one predominating on tundra areas varying between a black sandy loam and a sandy clay loam over a blue clay subsoil. The tundra soils are rich in humus or decayed vegetation and often approach a heavy peaty nature. The rocky areas are chiefly of gravelly sandstone soil and quartz to jagged limestone, in some places volcanic. On the coast range permanent frost occurs 1 to 3 feet below the surface, and in some sections, as at Kotzebue Sound, Wainwright, and Barrow, solid ice is frequently found immediately along the coast at a depth of 2 to 3 feet.

A FORAGE FACTOR

Lichens vary considerably in their habitat requirements. Some prefer rocks or stones, some the bark of trees, some the soil, and others the mosses, decayed herbaceous vegetation, decayed wood, or shrubs. Again, some prefer a sandstone rock, others a limestone or quartz. Of lichens which grow on the ground, some prefer moist peaty soil, some a calcareous soil, some silicious, some argillaceous, and some a hardened mud. Thus the soil and ground conditions determine in a measure the lichen cover and control protective management of the forage type. In Alaska the best lichen growth for

forage purposes is usually made up of those species that grow on the soil and on decayed herbaceous vegetation.

FORAGE COVER

The main forage cover on the winter coast range consists of a lichen type with a sedge-browse subtype; that on the winter interior range a lichen type with a browse subtype.

On summer coast range, a sedge-browse type predominates; and in the interior a browse-sedge-lichen type. Table 3 gives a summary of the average types observed on summer and winter ranges in various sections. (See pls. 10 and 11.)

TABLE 3.—*Summary of forage types in the stand on summer and winter ranges showing in percentages the composition density, palatability, and forage value*[1]

Section	Composition					Density	Palatability	Forage value
	Lichen	Browse	Sedge	Weeds	Moss			
Coast summer range:								
St. Lawrence Island	0	5	91	3	1	90	65	58.5
Kivalina	5	15	47	31	2	79	68	53.7
Kotzebue Sound	10	26	51	5	8	93	64	59.5
Seward Peninsula	7	15	53	24	1	68	60	40.8
Norton Sound	11	22	50	5	12	92	51	46.9
Yukon-Nunivak Island	9	15	57	15	4	90	60	54.0
Kuskokwim	6	40	34	17	3	70	67	46.9
Average	7	20	55	14	4	83	62	51.4
Interior summer range:								
Broad Pass	18	28	27	12	15	96	70	67.2
Gulkana-Tangle Lakes	16	34	29	10	11	88	68	59.8
Average	17	31	28	11	13	92	69	63.5
Coast winter range:								
St. Lawrence Island	65	12	2	11	10	40	80	32.0
Kotzebue Sound	50	25	15	10	0	60	70	42.0
Seward Peninsula	50	15	30	5	0	70	75	52.5
Norton Sound	50	10	30	4	6	87	67	58.3
Yukon-Nunivak Island	50	10	30	2	8	99	66	65.3
Kuskokwim	47	30	10	3	10	70	70	49.0
Average	52	17	20	6	6	71	71	50.0
Interior winter range:								
Broad Pass	50	20	8	4	18	85	76	64.6
Gulkana-Tangle Lakes	53	23	11	6	7	85	83	70.5
Average	52	22	10	5	13	85	80	67.5

[1] Forage value derived by multiplying the percentage of density of forage stand by the percentage of palatability.

The forage plants on the summer range consist chiefly of such herbaceous and shrub vegetation as grasses, sedges, weeds, and browse, and are eminently suited to grazing. They are highly organized seed-bearing plants of strong tissue and firmly rooted in the soil. Most of the Alaskan species are perennial plants reproducing both vegetatively and from the seed. They grow rapidly, produce substantial foliage, and are not readily injured under grazing use. Making annual and rapid growth, they produce a successive forage crop from year to year.

B26754

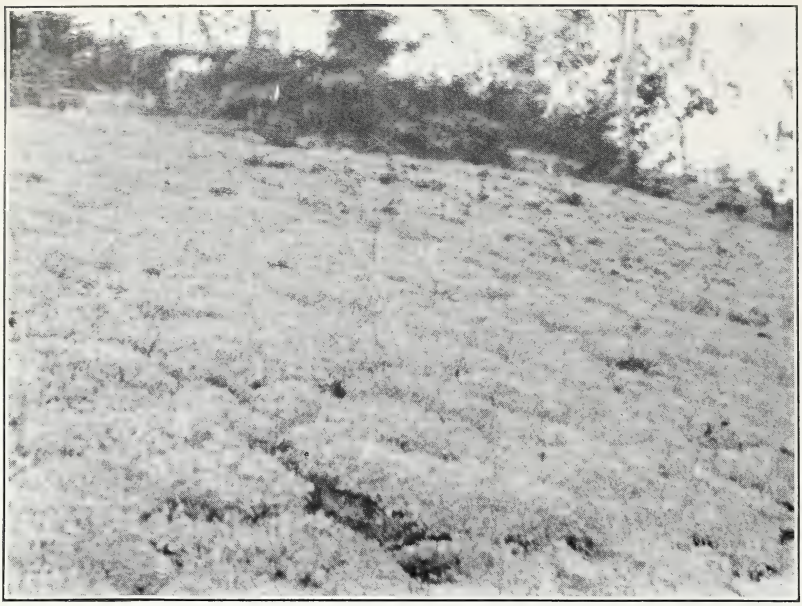
FIG. 1.—TIMBER, GRASS, AND WEED TYPE OF RANGE

A luxuriant cover of grasses and weeds, usually found along the banks of streams

B26410

FIG. 2.—TUNDRA COVER OF SEDGES AND BROWSE

Most frequent forage type of the coast summer range



B26464

FIG. 1.—TIMBER AND LICHEN TYPE OF FORAGE

Lichen cover often found on the island mountain slopes. The lichens in this case form 85 per cent of the forage stand

B26507

FIG. 2.—TUNDRA AND LICHEN TYPE OF FORAGE

Under favorable conditions a growth of lichens may sometimes occur on the immediate coast. The lichens in this case comprise 50 per cent of the forage stand. The men were gathering and sacking them for use at the former reindeer experiment station at Nome

The most important plants may be grouped, according to abundance, as follows:

MOST ABUNDANT

Eriophorum callitrix (cotton sedge).
Eriophorum angustifolium (cotton sedge).
Salix spp. (willow).
Betula rotundifolia (ground birch).
Ledum spp. (Labrador tea).
Empetrum nigrum (crowberry).
Vaccinium uliginosum (blueberry).
Vaccinium vitis-idaea (mountain cranberry).
Rubus chamaemorus (cloudberry).
Arctous alpina (Alpine bearberry).

FAIRLY ABUNDANT IN PLACES

Arctagrostis latifolia (Alaska bunch grass).
Calamagrostis scabra (coast bluejoint).
Elymus mollis (dunegrass).
Festuca rubra (fescue).
Poa (bluegrass).
Carex (sedge).
Equisetum (horsetail).
Betula kenaica (birch).
Alnus alnobetula (alder).
Dryas octopetala (dryad).
Artemisia arctica (wormwood).
Artemisia tilesii (wormwood).
Aconitum delphinifolium (monkshood).
Coelopleurum gmelini (sea-parsnip).
Lupinus arcticus (lupine).
Lathyrus maritimus (beach pea).
Mertensia paniculata (bluebells).
Galium boreale (bedstraw).
Pedicularis (fernweed).
Epilobium angustifolium (fireweed).

VERY SCATTERING BUT FREQUENT

Spiraea steveni (spirea).
Robus arcticus (raspberry).
Cornus suecica (bunchberry).
Andromeda polifolia (bog rosemary).
Phleum alpinum (wild timothy).
Agrostis (redtop).
Astragalus (milk vetch).
Oxytropis (oxytrope).
Petasites frigida (butterbur).
Senecio (groundsel).
Saxifraga (saxifrage).
Iris setosa (arctic iris).
Polemonium acutiforum.
Capnoides pauciforum.
Valeriana capitata (valerian).
Campanula (bellflower).
Sanguisorba sitchensis (burnet).
Arenaria (sandwort).
Arnica (arnica).
Gentiana (gentian).
Pedicularis (fernweed).
Polygonum (smartweed).
Primula (primrose).
Heterotrichum (wool aster).
Chrysanthemum (daisy).
Bupleurum americanum (hare's-ear).
Anemone.
Ranunculus (buttercup).
Eritrichum arctioides (forget-me-not).
Silene acaulis (moss campion).
Viola (violet).
Cerastium (chickweed).
Cardamine (bitter cress).
Ligusticum scoticum (Scotch lovage).
Potentilla (five finger).
Stellaria (starwort).
Rumex acetosa (sorrel).
Rumex occidentalis (dock).

FORAGE PLANTS GRAZED BY REINDEER

SPRING FORAGE

The first fresh growth in spring usually consists of young shoots or flowering stalks of the cotton sedges and of grasses and weeds. The reindeer are very fond of fresh green growth and in grazing on the hummocks miss very few of the new shoots. They feed also in spring to a small extent upon willow buds, reindeer lichens, and Labrador tea.

SUMMER FORAGE

During the summer the reindeer enjoy a great variety of range plants, but chiefly sedge and browse species. At the beginning of the season, in addition to their main food of sedges and willow

browse they are particularly fond of the succulent young grasses of various kinds and of such herbs as wormwood, fernweed, vetch, fireweed, smartweed, dock, horsetail, sea-parsnip, and groundsel. In the middle and latter part of the summer they feed mainly on sedges, various species of browse, lichens, mushrooms, and the more succulent herbs. Mosses are eaten only incidentally, mixed with the other forage.

In the order of relative forage value, the plants grazed during the summer may be listed as follows:

(1) Most important, because of high palatability and greatest abundance:

Eriophorum callitrix (small cotton sedge).
Eriophorum angustifolium (large cotton sedge).
Salix (willows).
Cladonia (mostly) (lichens).
Betula rotundifolia (ground birch).
Ledum decumbens and *L. groenlandicum* (Alaska tea).

(2) Of medium importance, because of high palatability and only local abundance or of medium palatability:

Alnus alnobetula (alder).
Vaccinium vitis-idaea (mountain cranberry).
Empetrum nigrum (crowberry).
Vaccinium uliginosum (blueberry).
Dryas octopetala (dryad).
Ranunculus pallasii (water buttercup).
Equisetum (horsetail).
Valeriana capitata (valerian).
Pedicularis spp. (fernweed).
Epilobium angustifolium (fireweed).
Artemisia arctica and *A. tilesii* (wormwood).
Lupinus arcticus (lupine).
Astragalus alpinus and *A. littoralis* (vetch).
Polygonum alaskanum (smartweed).
Rumex occidentalis (dock).
Coelopleurum gmelini (parsnip).
Ligusticum scoticum (Scotch lovage).
Carex (sedge).
Poa (grass).
Arctagrostis, Calamagrostis, Festuca, Agrostis, Phleum (grasses).

(3) Of less importance, because of lower palatability:

Rubus chamaemorus (cloudberry).
Ribes triste (currant).
Viburum pauciflorum (cranberry bush).
Rubus arcticus (raspberry).
Arctous alpina (alpine bearberry).
Betula kenaica (birch).
Conioselinum gmelini (hemlock parsley).
Bupleurum americanum (hare's-ear).
Merckia physodes (beach starwort).
Lathyrus maritimus (beach pea).
Mertensia paniculata (bluebells).

The palatability of numerous other species of the herbaceous vegetation has not yet been determined, but they are generally of minor importance because of infrequent occurrence.

FALL FORAGE

Toward fall the reindeer graze more and more on lichens, their chief food consisting then of lichens, sedges, willows, ripened tops of grasses, and perhaps some of the other browse species.

WINTER FORAGE

During the winter season, the forage consists almost entirely of the various lichens. The species of *Cladonia* are the most important because of their high palatability and great abundance.

The species of *Cetraria* and *Stereocaulon* are also important but less abundant. Browse and dried herbaceous vegetation are taken to some extent and occasionally some of the mosses.

THE LICHEN PLANT

The plants that furnish the bulk of the forage on winter range are lichens. They are entirely different from herbaceous and shrub vegetation in character and in reaction to grazing use. They do not, like the herbaceous vegetation, furnish a renewed forage crop from year to year, but require a long period of years to recover from one season's cropping. Lichens grow very slowly and are of limited height, but attain a very great age. They are of comparatively delicate structure, infirmly anchored to the soil, and are readily removed either by trampling or picking by hand. Under summer conditions they often become dry and brittle and are then easily destroyed. When moist or wet they are of almost spongy texture and then less easily injured.

The lichen plant is a composite organism—an alga and a fungus living together. The relationship has become so intimate that lichens are often regarded as autonomies or morphological units rather than symbiotic colonies of algae and and fungi. The frutification of the lichen is that of the fungus, and reproduction takes place by means of the spore. Many lichens also multiply asexually by means of soredia, produced by the chlorophyll-bearing cells, gonidia, which belong to the algae, the soredia escaping from the lichen thallus usually in the form of a fine powder, and germinating immediately to form new plants. A third mode of reproduction is by the distribution of fragments of the plants by action of wind or animals.

GROWTH HABITS OF LICHENS

Lichens grow under a great variety of conditions of climate and habitat. (Pls. 12 and 13.) Their general distribution both vertically and horizontally is extensive. All are capable of enduring desiccation for long periods without losing their vitality. Their height is limited, but the size to which they may attain varies with individual species and habitat. Along the Alaskan coast, the average growth of the mixed stand is 4 or 5 inches, although in places a 10-inch height has been found (pl. 13, fig. 2). Some species are of diminutive size and consequently of little or no use for grazing; others are of luxuriant growth and highly valuable.

Lichens grow chiefly on soil, on rocks or stones, and on the bark of trees; but they also grow frequently on decayed logs and on mosses, and sometimes on the thalli of other species. According to the base upon which they grow they are classified as terricoline (on soil), corticoline (on bark), saxicoline (on rocks), and muscicoline (on mosses). Those most important for forage in Alaska are largely of terricoline habit. The essentially saxicoline, muscicoline, and corticoline species, with a few exceptions, are mostly of diminutive size or of low form adhering closely to the substratum, and therefore of low grazing value.

Some species of lichens form leaf-like expansions (foliaceous), some are cup shaped, some closely encrust the surface on which they grow (crustaceous), and others are shrublike (fruticose), the branches in this case being either cylindrical or flattened. Their colors vary from almost white to greenish gray, yellow, orange, brown, or a purplish black. Changes in color are greatly influenced by degrees of light and moisture or the nature of the habitat. In Alaska the fruticose lichens form the bulk of the winter forage. (Pls. 14–17.)

For their growth lichens require moisture, light, and heat, and probably derive some inorganic substances from the base upon which they grow, but most lichens probably take a smaller proportion of their food from the substratum and a larger proportion from the air than do the higher vascular plants. They take carbon dioxide from the air in the processes of nutrition, build up lichenin, a substance similar to starch, and return free oxygen to the atmosphere. When wet and in a partially decomposed condition, some lichens are often of a gelatinous consistency. The thallus of some species contains a bitter principle, which in a few instances may make the plant unpalatable to stock.

LICHEN OCCURRENCE AND DISTRIBUTION

On Alaskan coast ranges the best lichen growth is often found on west and north exposures. In thick stands of forest or brush very little of it occurs, but at the edges or in openings in the forest, or in scattering tree growth, a luxuriant lichen cover may usually be found (pl. 12, fig. 1). On moist tundra flats of favorable soil and atmospheric conditions, as on Nunivak Island, lichen growth may be abundant, both in volume and density (pl. 12, fig. 2). On the average summer tundra range of the coast, however, the herbaceous and shrub vegetation competes predominantly with the lichens. On the more rugged inland country the competition is reduced and the lichens often become the predominant vegetation. Here the best lichen cover of value for grazing is on the lower slopes, in coves, and hollows, and at the heads of creeks. The best individual growth occurs particularly in depressions on slopes and in swales and is most luxuriant in hollows between and at the bases and sides of hummocks. Certain valuable species, however, of comparatively short height often occur abundantly on the tops of hummocks in favorable situations and under minimum competition. On rocky upper slopes and tops of ridges the lichen cover becomes scattering and is usually small or dwarfed.

Even among the best of lichen types a pure stand does not occur, either with reference to class of vegetation or to individual species. Generally an admixture of lichens with other vegetation is found, as species of browse, mosses, and sedge. Often in the lichen stand there may occur a considerable portion of such mosses as *Sphagnum* and *Polytrichum*. On most of the winter ranges the lichens average 50 per cent of the cover, although some forage types occur that may contain as much as 90 per cent lichen vegetation.

Within the stand the lichens grow more or less intermingled in a solid mat, with species intermixed generally, but often by indi-

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FIG. 1.—OCCURRENCE OF CLADONIA ALPESTRIS

Scattering rounded patches of white. The *alpestris* community is closely surrounded by a mixture of other darker-colored lichens

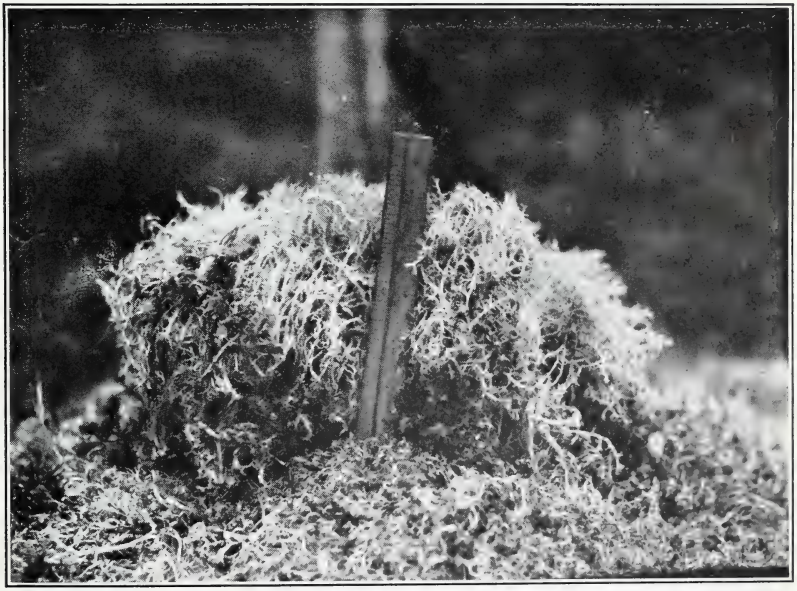

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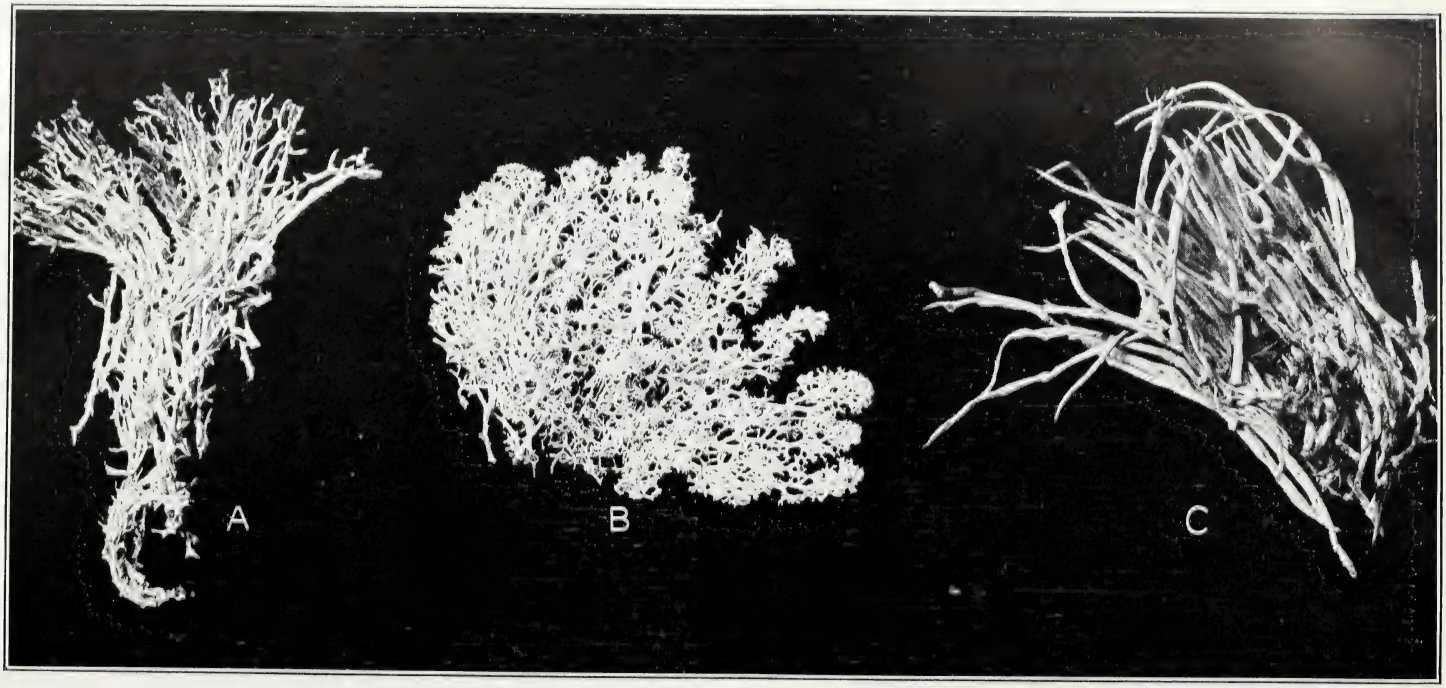
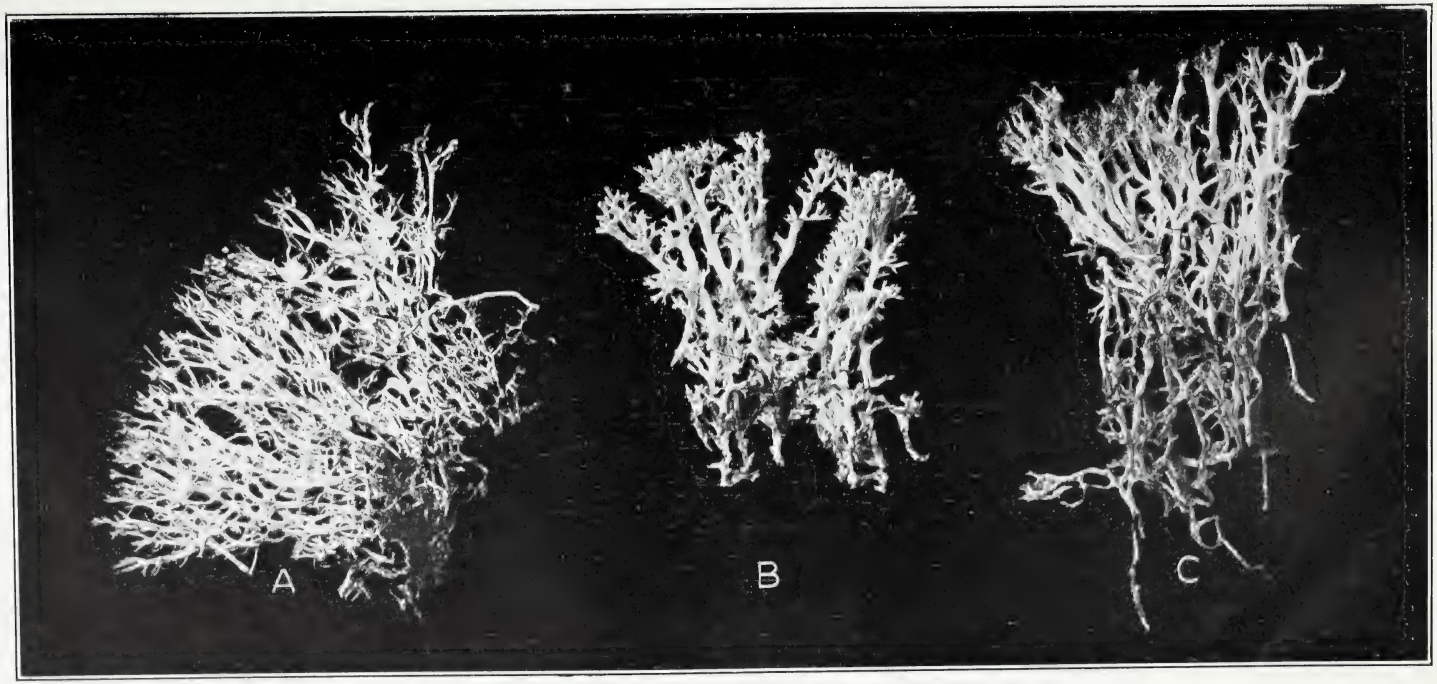
FIG. 2.—OCCURRENCE OF CLADONIA SYLVATICA SYLVESTRIS

A thickly matted growth, averaging 4 or 5 inches in height and in places reaching 10 inches



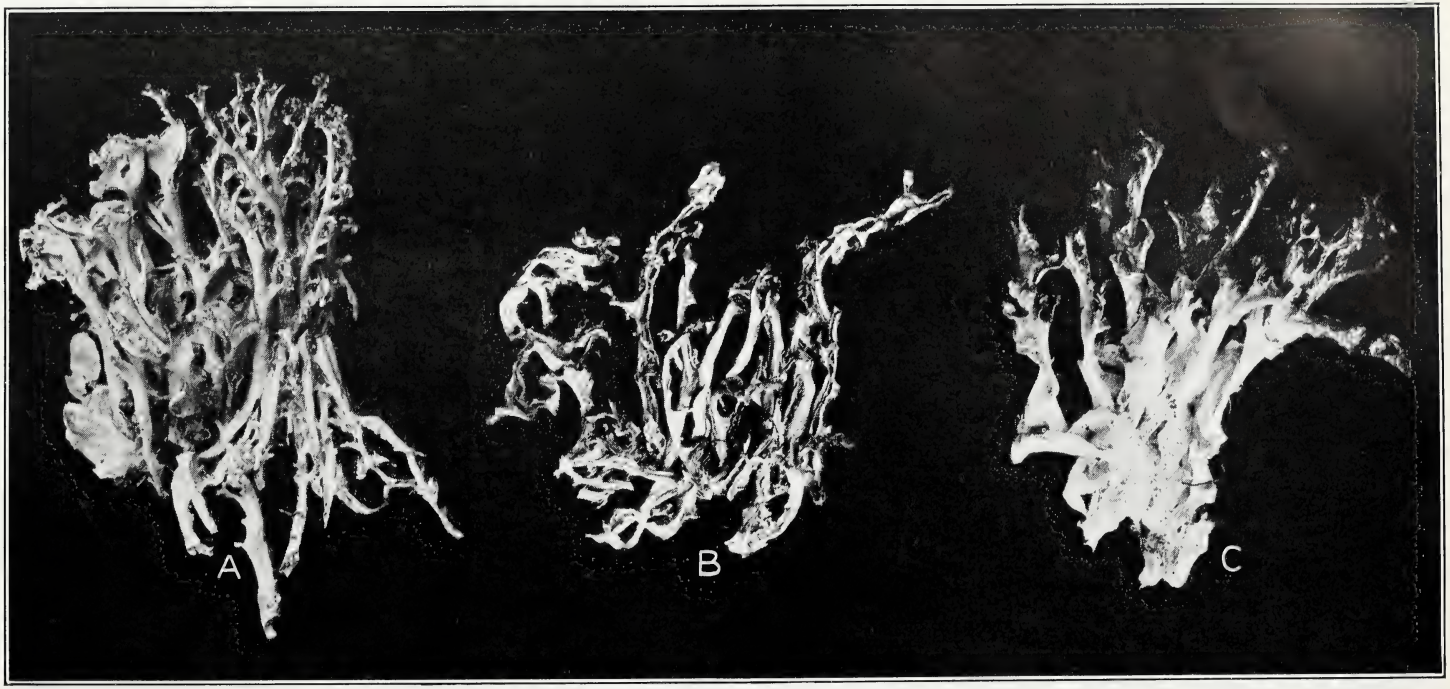
FORAGE LICHENS OF THE CLADONIA GROUP

A, *Cladonia delesserii*. B, *Cladonia alpestris*. C, *Cladonia gracilis elongata*



FORAGE LICHENS OF THE CLADONIA GROUP

A, *Cladonia amaurocrea*. B, *Cladonia uncialis turgescens*. C, *Cladonia uncialis*



FORAGE LICHENS OF THE CETRARIA GROUP

A, *Cetraria cucullata*. B, *Cetraria islandica*. C, *Cetraria islandica platyna*

vidual groups or patches of one or two species (pl. 13, fig. 1). Frequently some one or two species predominates and numerous other species of various kinds are scatteringly intermixed with the base plant. Ordinarily, a handful of lichens picked up off the range will be found upon analysis to contain six or seven or more different species closely intermixed. *Cladonia* is the most abundant of the lichens in Alaska, both in number of species and in quantity; *Cetraria* is second in importance, but of scattering occurrence.

The predominating species on tundra and lower foothills sites are *Cladonia sylvatica sylvestris*, *C. rangiferina*, and *C. sylvatica*, or a combination of these. On a rocky subalpine site of favorable exposure, the predominant plant may often be *C. alpestris*. On higher range, the main plants are often species of *C. amaurocraea* and *C. uncialis*, and sometimes abundantly mixed with them *C. sylvatica sylvestris*. On rocky upper slopes and tops of ridges of inferior cover, the *Cetraria* species often predominate. Some species are cosmopolitan in distribution, occurring scatteringly throughout all types, as *Cetraria cucullata*, *C. islandica*, and *Cladonia gracilis elongata*. On rocky upper areas *Cetraria nivalis*, *C. islandica crispa*, *Cladonia gracilis dilatata*, and *Alectoria nigricans* are commonly found. *Cladonia sylvatica sylvestris* stands out generally as the most abundant and widespread and therefore most important winter forage plant on the coast range.

The more important species of lichens occurring on the coast ranges may be grouped as follows:

(1) Most abundant:

Cladonia sylvatica sylvestris.
Cladonia rangiferina.
Cladonia sylvatica.
Cladonia gracilis elongata.
Cladonia amaurocraea.
Cladonia amaurocraea oxyceras.
Cetraria cucullata.
Cetraria islandica.
Alectoria nigricans.
Alectoria ochroleuca.
Cladonia uncialis.
Cladonia uncialis turgescens.

(2) Fairly abundant in places:

Cladonia uncialis obtusata.
Cladonia alpestris.
Cladonia gracilis ecmocyma.
Cladonia amaurocraea celotea.
Stereocaulon alpinum.
Stereocaulon coralloides.
Stereocaulon tomentosum.
Cetraria chrysantha.
Cetraria nivalis.
Cetraria islandica crispa.
Cetraria islandica platyna.
Sphaerophorus coralloides.

(3) Scattering but frequent:

Cladonia (cup cladonias).
Ochrolechia sp.
Parmelia sp.
Cladonia furcata.
Cladonia delessertii.
Cladonia crispata.
Cladonia degenerans.
Thamnolia vermicularis.
Nephroma arcticum.
Lobaria linita.
Cladonia gracilis dilatata.
Cladonia decorticata.
Cladonia squamosa muricella.

(4) Infrequent:

Cladonia botrytis.
Cladonia subsquamosa.
Cladonia cenotea.
Cladonia cyanipes.
Dactylina arctica.
Duforea ramulosa.
Icmadolphila ericetorum.
Pertusaria bryontha.
Pilophorus cereolus robustus.
Philophorus cereolus acicularis.
Cetraria juniperina.
Cetraria hiascens.

(4) Infrequent—Continued.

Cetraria fahlunensis.
Letharia thamnodes.
Siphula ceratities.
Lecanora sp.
Alectoria divergens.
Psoroma hypnorum.
Ramalina dilacerata.
Gyrophora sp.

In relative forage value, the lichens may be listed as follows:

(1) Most important, because of high palatability and greatest abundance:

Cladonia sylvatica sylvestris.
Cladonia rangiferina.
Cladonia sylvatica.
Cladonia alpestris.
Cladonia amaurocraea subspp.
Cladonia amaurocraea celotea.
Cladonia amaurocraea oxyceras.
Cladonia uncialis.
Cladonia uncialis obtusata.
Cladonia uncialis turgescens.
Cladonia gracilis elongata.
Cetraria cucullata.
Cetraria islandica.

(2) Of medium importance, because of lower palatability and only local abundance or of medium palatability:

Cladonia delessertii.
Cladonia decorticata.
Cladonia squamosa subsp.
Cladonia degenerans.
Cladonia amaurocraea celotea.
Cladonia amaurocraea crasipedia.
Cladonia uncialis adunca.
Cladonia gracilis dilatata.
Cladonia gracilis ecmocyma.
Cetraria islandica crispa.
Cetraria islandica platyna.
Cetraria nivalis.
Cetraria richardsonii.
Alectoria ochroleuca.
Dactylina arctica.
Nephroma arcticum.
Stereocaulon alpinum.
Stereocaulon coralloides.
Stereocaulon tomentosum.

(3) Of value only as mixed with other species, because of very scattering occurrence:

Cladonia bellidiflora.
Cladonia crispata subspp.
Cladonia deformis extensa.
Cladonia digitata glabrata.
Cladonia furcata.
Cladonia cyanipes.
Cladonia alpicola.
Cladonia cenotea.
Cladonia fimbriata.
Cladonia alaskana.
Cladonia gracilis chordalis.
Cladonia gracilis.
Cladonia gracilis subtilacerata.
Cladonia subsquamosa.
Cladonia sylvatica laxiuscula.
Cladonia uncialis turgescens.
Cladonia alpestris inturgescens.
Alectoria nigricans.
Cetraria aculeata.
Cetraria chrysantha.
Cetraria hiascens.
Cetraria islandica crispa.
Cetraria islandica platyna.
Sphaerophorus coralloides.
Duforea ramulosa.
Letharia thamnodes.
Thamnolia vermicularis.
Parmelia spp.

(4) Of little or no value, because of diminutive size, infrequent occurrence, mode of growth, or unpalatableness:

Cladonia botrytis.
Cladonia coccifera subspp.
Cladonia degenerans euphorea.
Cladonia pyxidata subspp.
Cetraria juniperina.
Cetraria juniperina terrestris.
Alectoria jubata.
Icmadolphila ericetorum.
Lecanora spp.
Lecidea spp.
Lobaria spp.
Ochrolechia spp.
Peltigera spp.
Physcia pulverulenta muscigena.
Psoroma hypnorum.
Pertusaria bryontha.
Pilophorus cereolus robustus.
Ramalina dilacerata.
Siphula ceratities.
Xanthoria lychnea pygmaea.
Gyrophora spp.

REACTION OF LICHENS TO GRAZING USE

To study the reaction of the lichen plant to grazing use, cutting and other quadrats have been established to supplement general

range observations. From results thus far obtained facts have been brought out regarding reproduction and recovery from injury that have an important bearing on the range management problem. The conclusions drawn are here stated, and, though not complete, are indicative of what may be expected in grazing a lichen range.

GROWTH AND REPRODUCTION

The lichens are rapid in rate of reproduction or establishment of new plants. Reproduction and growth take place whenever favorable conditions of high moisture exist, usually in spring and fall. In a wet season growth may continue throughout the summer, but ordinarily the summers are dry and hot, and the lichens then lose their moisture, become brittle, and stop growing. Growth may continue into the winter also in sheltered, rocky situations where the action of the sun on the frozen surface yields water easily.

The average rate of growth of young plants of the species most important as reindeer forage is about an eighth to a quarter of an inch a year, and the initial growth is usually about a sixteenth to an eighth of an inch. In volume—that is, number—of new plants it is indicated that the lichens make rapid progress; in one measured area on overgrazed range they attained about half the normal volume over a period of five years following denudation, or four years following the first appearance of new growth. Or from 1920 to 1923 there is shown on this particular area a progressive annual increase in volume at the rate of approximately 50 per cent. At this rate the normal stand in volume or density of cover, which in this case is 40 per cent of lichen vegetation, should be reached in another two years—that is, seven years following denudation. The plants coming in on this area, in the order of their importance, were *Cladonia sylvatica sylvestris*, *Cetraria cucullata*, *Cladonia bellidiflora*, *C. coccifera*, *Sphaerophorus coralloides*, *Alectoria nigricans*, *Cetraria islandica*, *Cladonia gracilis elongata*, and *C. alpestris*.

On the basis of the foregoing rates of growth and recovery, it would usually require 7 to 10 years of protection for a lichen range to come back to normal volume following initial growth; and 15 to 20 years to attain a normal height of 4 to 5 inches. These estimates, however, are not final, more years of observation being necessary, but the relative rate of recovery is apparently very slow and by reason of this fact, the proper management of winter range presents an exceptionally important problem.

QUADRAT STUDIES

Further results obtained on several observation quadrats 1 meter square (pl. 18) tended to substantiate these estimates and provided additional information on the action of lichen growth under partial cropping, represented artificially by cutting. These quadrats, established within inclosures, were on range containing a high percentage of lichen vegetation (from 70 to 90 per cent). The height of the vegetation was from 3 to 4 to 6 inches, and occasionally 2½ inches at the lowest and 10 inches at the highest. The average height in all cases would be between 4 and 5 inches.

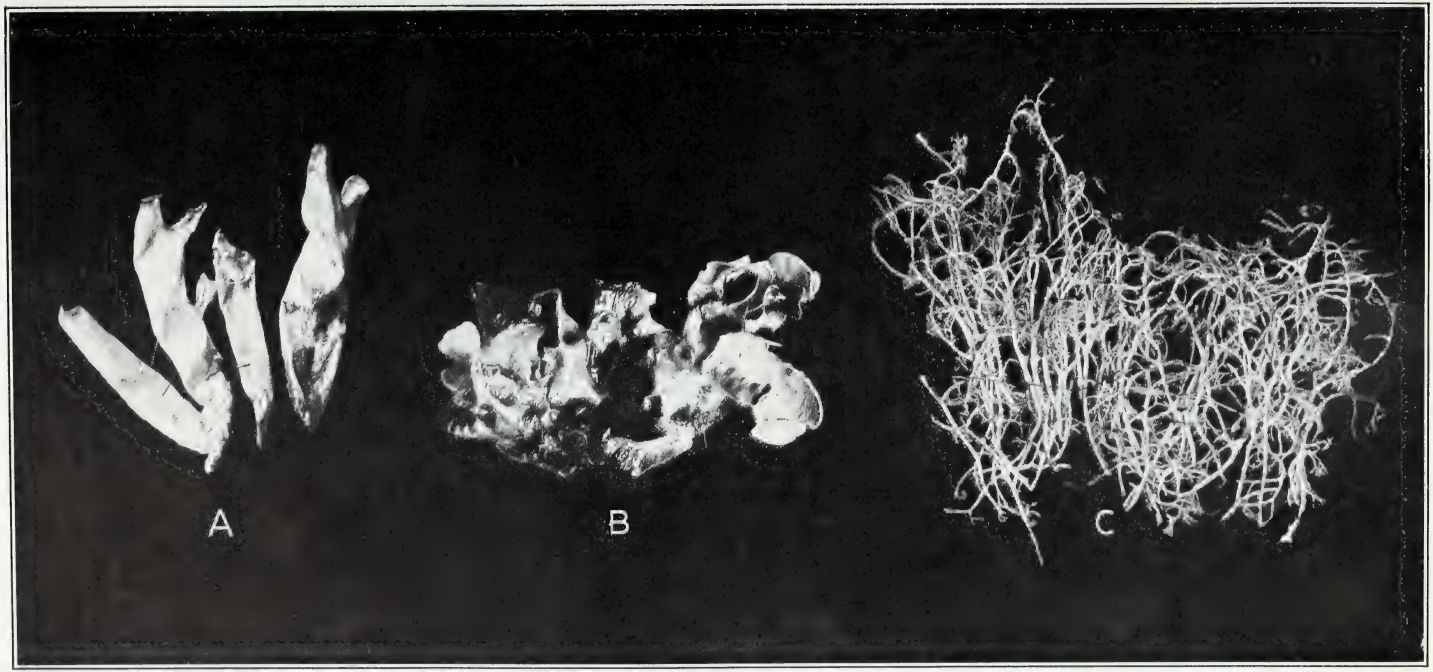
Within each inclosure four plots were laid out: (1) A check quadrat; (2) one on which the cover was entirely removed and the ground trampled; (3) one on which the vegetation was half cut to remove the top portion; and (4) one on which the lichen vegetation was picked by hand or, as in one case, scraped to frost. Scraping to frost under winter conditions removed about the top two-thirds of the vegetation, leaving the plant base intact; and picking under thawed conditions removed most of the plant but left the soil undisturbed.

Examination of quadrats following one and two years of recovery showed that in all cases where the lichen cover had been half cut, about half the vegetation had been killed and the remainder was still in growing condition. There was no evidence of reproduction, the dead and living cover being so matted that no new plants came in. New growth on the living plants, however, was evidenced in the form of numerous small side shoots on the cut tips and branches. Following a two-year period these new shoots were numerous and averaged about an eight of an inch long; where there had been only one year of recovery the shoots were less numerous, averaging about a sixteenth of an inch long. The effect of cutting lichens in this case closely parallels what takes place in pruning a hedge or trimming off the top of a tree.

The scraped-to-frost quadrat was established on April 19, when the surface of the ground was frozen and covered with a light snow. The snow was lightly brushed away and the lichen vegetation scraped entirely off with a hand rake to the frozen surface, leaving the plant base intact and protected by being frozen into the ground. About 2 or 2½ inches of cover was removed. Later, upon examination following thawing, a cover of half an inch to an inch of lichen plant stubs was found remaining on the area. Examination following recovery after two seasons showed two-thirds of this cover completely killed and the remainder still showing signs of life. New growth in this case as in the area half cut took the form of many small offshoots on the cut tips and branches, a sixteenth to an eighth of an inch long. No new plant or reproduction was observed, the matted cover of dead and living vegetation probably obstructing.

On all the denuded quadrats a scattering reproduction was found following one and two years of recovery, in one case about a hundred new plants showing on the area following the two-year period. The species occurring, in the order of their importance, were *Cladonia* (probably *sylvatica sylvestris*, *rangiferina*, and *sylvatica*), *Cetraria cucullata*, *C. islandica*, and *Stereocaulon tomentosum*. The reproduction seemed to spring mostly from the old remnants of plants left scattered over the quadrat area, appearing also along the sides of the area by spreading from the adjoining cover. The new growth measured about a sixteenth to an eighth of an inch high.

The picked quadrats differed from the denuded quadrats only in degree of denudation. Such nonlichen vegetation as sedges and browse was left standing, with the soil undisturbed, and although the lichen cover was in the main removed, some of the plant base may have been left intact. The beginning of reproduction was evidenced on these areas at about the same rate as on the denuded quadrats. In addition, however, it was found that in a few in-



FORAGE LICHENS LESS IMPORTANT BECAUSE LESS ABUNDANT

A, *Dactylina arctica*. B, *Nephroma arcticum*. C, *Alectoria ochroleuca*

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FIG. 1.—LICHEN QUADRAT, UNTOUCHED

Area established for study at Unalakleet, Alaska, April, 1922

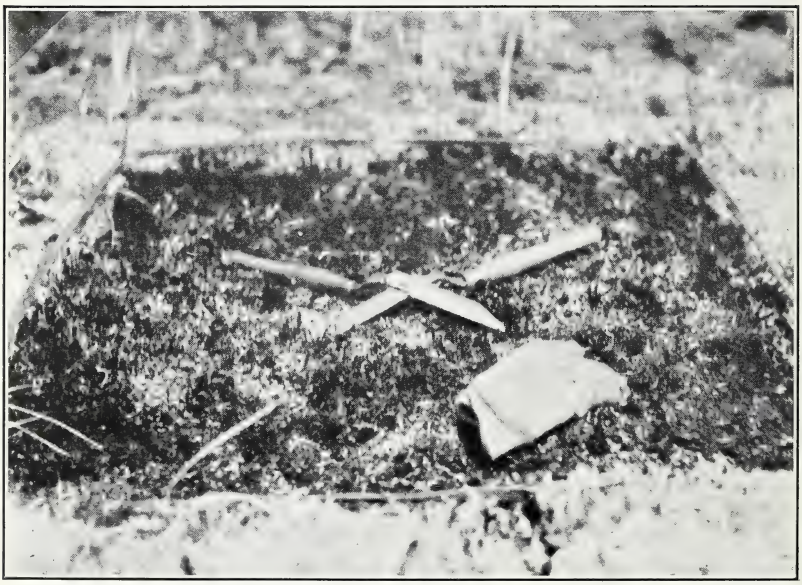

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FIG. 2.—LICHEN QUADRAT, COVER REMOVED

Same area as in Figure 1. Photographed after vegetation had been removed by picking, to note the later recovery

stances where an occasional plant base or small plant had been left standing, growth was continuing. The new reproduction measured a sixteenth to an eighth of an inch high, and the few old plants left standing measured 1 or 1½ inches high.

RANGE RECOVERY

The beginning of lichen reproduction takes place one or two years following denudation. Reproduction comes in best where the ground has been cleared of the matted growth, giving the young plants a chance to develop. Where the top of the plant is cropped, a growth of offshoots occurs which will probably result in a bushy, deformed top.

Cutting or cropping the lichen cover results in considerable damage, by killing a large proportion of the growth. The number of plants killed seems to be in direct proportion to the degree of cropping or grazing. Even light cropping or tramping may result in considerable damage. Much trampling in summer when the plants are dry and brittle may entirely kill out the cover. This means that the winter ranges must have complete protection from grazing during late spring, the summer, and early fall, or particularly when the surface is thawed and the lichens are dry and brittle. During winter, on the other hand, the lichens have regained their moist consistency and the ground is frozen with the base of the plant, thus offering considerable protection against ready destruction.

The quadrat observations apply to coast tundras, where it would seem that recovery of the lichen range following full cropping may take possibly 15 or 20 years. On higher ground, where a dry, rocky soil offers less favorable conditions for good growth, undoubtedly recovery will take much longer, perhaps as much as 25 or even 30 years. The rate of recovery of a lichen range depends very much on the site conditions.

RANGE FIRES

One of the greatest sources of injury to range and losses of forage in Alaska is in fires, which in most cases are deliberately set or are due to carelessness. Tundra fires along the coast are common, and burned-over range areas may be frequently found. Fires are often set by prospectors to clear off the vegetation and thus expose the underlying ground and rock or by Eskimos in an effort to be rid of mosquitoes. They are also caused by carelessly leaving a camp fire burning or tossing away a lighted match or cigarette.

Possibly on account of the immensity of the country and the sparse population the injury by fire does not appear very impressive nor a need of its suppression important. It has not, perhaps, been called sufficiently to people's attention in the past, although a Territorial law is in effect providing penalty for the deliberate setting of range fires. What is needed for Alaska is a general fire-prevention program, and in that connection a wide, educational propaganda against forest and range fires, particularly in the northern and western sections of the Territory, reaching the Eskimos through the schools.

Damage to range by fire involves not only loss of forage and trees but also of game and fur animals, since the small ground animals as well as the cover of vegetation are destroyed by the fire.

The damage to lichen range is particularly serious. It may take a burned-over lichen area as much as 25 years to come back; or where so badly burned that the cover of humus is destroyed, the changed site conditions may result in a recovered stand of inferior species, or virtually in a permanent removal of the lichens, so far as practical grazing use is concerned. In view of the importance of the lichen areas for winter grazing, it is vital to all reindeer men to guard against fires; and because of the damage to game and fur animals and to tree growth, it is the concern of everyone that fires be prevented and fire protection sought.

CARRYING CAPACITY OF RANGE

WINTER REQUIREMENTS

Brief studies of carrying capacity conducted on a range in the Norton Sound section indicate a requirement of 30 acres for each reindeer for the yearlong period. This, however, does not allow for a recovery period for the lichen areas under full cropping; consequently, a higher yearlong acreage must be allowed. For the six months of summer grazing, 10 to 15 acres a head are required, and in some cases 8 acres, but for winter grazing on lichen forage the requirement is much higher for proper range use and protection. As regards carrying capacity generally, winter grazing requires a larger acreage than summer for a number of reasons:

First, the lichens which constitute the principal winter food are, as mentioned, wholly different from the herbaceous vegetation making up the summer forage, in nature, habits of growth, and reaction to injury. By reason of these differences greater care must be taken in grazing lichen areas to avoid total destruction of the individual plants or checking their continued healthy growth and reproduction.

In the second place, the inland winter areas and top country generally are not so well covered with vegetation as the summer areas adjacent to the coast or lying along the lower foothills. Much of this top country may be almost barren in places, or the lichen growth of patchy occurrence. In some cases only a third or a half of the total winter range may be available for grazing use. The average summer range, on the other hand, is usually of full cover and the total acreage is available for grazing. Thus an increased acreage is required for winter grazing to provide sufficient forage.

Further, reindeer graze more quietly over a smaller area in winter than in summer, and remain for the most part in one general locality. This means closer utilization and greater danger of overgrazing. To offset this and to guard against overuse, a larger acreage must be provided to put into effect a scheme of deferred and rotation grazing.

All three factors, then, point to the necessity of a larger acreage requirement under winter grazing, although the second factor may result in considerable variation in the final estimate given as between different localities.

CARRYING CAPACITY ESTIMATES

For the reindeer ranges, as now known, a carrying capacity of 10 or 15 acres a head is indicated for summer grazing plus 30 to 45

acres for winter. Yearlong, this requirement would become 40 to 60 acres. The extensive reconnaissance thus far conducted indicates that 40 to 45 acres a head will probably apply generally to the Norton Sound section and south, and 50 or 60 acres for the Seward Peninsula and north. The Seward Peninsula, for example, now carries about 83,000 reindeer, and from computations of acreage and on a basis of a 60-acre requirement, it has a future carrying capacity of 200,000 head. A 60-acre requirement is fixed for the peninsula section at this time to insure a safe basis for stocking. Later, if it should be found that the range is not being fully utilized, following careful inspection of the individual allotments, a gradual increase may be made until full capacity is reached.

If, as indicated by the present studies, it may take a depleted lichen range from 15 to 30 years to recover, the importance of carefully protecting the winter ranges becomes readily apparent. Some system of deferred and rotation grazing must be devised, and sufficient acreage provided to make it practicable. Under a permit system, based on an estimated carrying capacity for each allotment, it would be advisable first to proceed on the basis of 60 acres a head, and then later, should underutilization be found, gradually to increase the stocking to full capacity, as determined by careful and continuous inspection.

On the basis of a 40 to 60 acre requirement, the total available range in Alaska suitable for grazing should support 3,000,000 reindeer. The coast section now occupied by herds should when fully stocked carry 1,000,000 reindeer.

MANAGEMENT

The reindeer herds in Alaska are rapidly increasing in size, so that better and proper methods of management are more important. Former methods of handling applicable to small herds are no longer sufficient; better and modern methods to conform to the larger herds must now be adopted. Under proper management and organization the reindeer industry has a promising future, but a decided change toward better methods must now take place if full progress is to be maintained.

RANGE CONTROL AND REGULATION

As a natural development of the growing use of the open range, some system of range control and grazing regulation is certain sooner or later to be established. Such a system, which is necessary if a permanent industry is to be built up, would contemplate the division of range into allotments, as determined by natural units, each owner being given a permit to graze a certain number of head upon a certain unit. In the presence of numerous small owners, this will require that reindeer be held in cooperative herds and that the owners organize into cooperative reindeer associations or livestock companies.

To avoid future difficulty it is undoubtedly best that Eskimo-owned and white-owned herds be kept separate as far as practicable. In instances of mixed ownership, where controversies arise, every effort should be made toward readjustment, and the herds should be separated and combined with others to obtain uniform ownership.

In some cases, where such a move may not be feasible at this time in full justice to all concerned, a cooperative herd by white and Eskimo owners must continue. But the attempted splitting up of a natural grazing unit, by dividing the herd and allowing the two or more parts to remain on the same unit, is impracticable.

With an allotment system in operation, definite assignment of range among owners may be made and a protective management adopted for each grazing unit. Such management would involve stocking the range on the basis of actual carrying capacity and proper control and distribution of stock in order to insure a uniform utilization based on the forage requirement. Careful herding, construction of range improvements, and eventually the adoption of range salting are important aids to proper control.

SUMMER RANGE MANAGEMENT

Protective management on summer ranges is a comparatively simple problem, and a ready solution is to be found since it involves a known quantity, namely, herbaceous and shrub vegetation, as grasses, sedges, herbs, and browse. Valuable information that applies directly is available in the publications on forage and range studies that have been conducted for many years on the grazing areas of the western United States. The principles determined by these studies apply to Alaska as well and may be followed in working out the management scheme. Proper seasonal grazing, deferred and rotation grazing, open grazing, and proper distribution of stock over the range must all be put into practice.

WINTER RANGE MANAGEMENT

The problem on winter range is more difficult. From the nature of the lichen forage it is evident that the treatment in range management will have to be much different from that applicable to such rapid-growing forage crops as grasses, sedges, herbs, and browse. Although one or two croppings of herbs and grasses may be safely permitted each season under a rotation grazing scheme of three years, without seriously injuring the growth or lowering a continued maximum forage yield, this could not be permitted with the slow-growing lichen vegetation. Recovery from cropping in this case requires not one season or part of a season, but several years. Instead of a three-year deferred and rotation grazing scheme, a more extended system will have to be worked out and applied.

Management of the winter reindeer ranges calls for a deferred and rotation scheme of grazing, but to what degree each area should be grazed before deferring is still uncertain. Observations suggest that probably one of two things must be done: (1) Either close utilization must be followed or (2) there must be a very light cropping. Close utilization to remove all cover down to the frozen ground will get the greatest value out of each crop and will open up the cover for readier reproduction. It will also be the easier method for the grazier.

Light cropping, on the other hand, would require greater movement of the herd, constant changing from one area to another, and

consequently more effort on the part of the grazier. In addition, much forage would be killed instead of being eaten upon a second grazing. Furthermore, the cover would not be opened up for ready reproduction, and it remains to be seen what sort of a second or renewed crop might be expected from an offshoot type of growth.

At present the writer favors the close utilization method, perhaps by alternate strips of range, and then by deferring the area over a period of several years, the period to be determined later as studies progress. In any case, complete removal of the cover would not take place on the winter range because of the protection afforded by the frozen ground.

The general management scheme, however, will vary with the nature of the cover and the character of the site. Closer utilization can probably be applied more readily on a tundra site of favorable moisture, a luxuriant cover, and a *Cladonia* vegetation. On a drier, rocky site with less-abundant plant growth, lighter utilization probably must be practiced. Again, heavier grazing may be withstood on an area of gentle topography than on one of steep slopes, and on the more sheltered areas than on those that are exposed. In any event, open grazing rather than massed grazing by the herd should be practiced on winter as well as on summer range, not so much to avoid close utilization as to prevent overutilization.

HERD MANAGEMENT

Not only is improvement in range management necessary, but better herd management also must be effected along the lines advocated in Department Bulletin No. 1089. The more important points to be considered in attaining a better herd management may be briefly summarized as follows: (1) Open herding; (2) proper castration by use of knife and emasculator; (3) reduction of herd bulls to the ratio of 5 to 10 for each 100 does; (4) selection of the largest and best bulls of dark color for breeding purposes; (5) elimination of white-colored and light-spotted animals from the breeding herd; (6) removal of scrub stock, both male and female, from the breeding herd—scrub stock and old barren females should be slaughtered; (7) injection of new blood into the herd by an interchange of bulls between herds, and by use of caribou bulls; (8) employment of the corral and chute method of handling the herd at round-up time for branding, castration, and separating, and abandonment of roping as much as possible; (9) use of a holding pasture for a large herd in connection with the corral; (10) marking fawns on a basis of percentage ownership; (11) organizing small owners by communities into livestock associations or companies, with one mark or brand adopted for each community herd, and in the case of the Eskimo, placing the best reindeer men in charge of the herd; (12) training and keeping in the herd at least 10 sled reindeer for each 1,000 head of stock.

The necessary reorganization of the round-up and herding operations in the majority of Alaska herds may be obtained by employing pack and sled reindeer in hauling supplies and getting over the range, and by constructing cabins on all parts of the range to facilitate efficient patrol. Where temporary tent camps must be relied

upon instead of cabins, and where the herder must carry his supplies and equipment on his back in hiking over the range, there can be no efficient herding or rounding-up of stock. When the herder must carry his own pack, the time he can spend out on the range is limited, and consequently on a large range he may fail to bring in all the stock at a round-up. Furthermore, hiking with a pack over Alaska tundra is grueling work and consequently not conducive to the best results. By using pack reindeer to carry his supplies, therefore, the herder's task is made easier; he is able to stay out on the range a long time; and by being able to cover his range thoroughly he is assured of a complete rounding-up of all stock. The use of permanent cabin camps, well situated to cover all parts of the range, is also an important aid in this respect. With supplies stored at these camps, the herder can conveniently work his range by patrolling between cabins and by working out from them during the round-up. The cabins also provide a comfortable abode and make reindeer herding a more attractive occupation.

SUMMARY

The stock of 1,280 reindeer imported from Siberia into Alaska between the years 1892 and 1902 has increased to approximately 350,000, not including about 125,000 utilized for food and clothing. The annual gross increase in herds is between 33 and 45 per cent. About a third of the Alaskan reindeer are now under white and two-thirds under Eskimo ownership in individual and company herds. One incorporated company owns about 50,000 reindeer in six herds.

In the two years 1924 and 1925 reindeer meat weighing more than 1,000,000 pounds was exported from Alaska, and a steady increase in the output and in the demand for it is indicated. The meat is fine-grained, compares favorably with beef, and when fresh is exceptionally juicy and tender.

A rapidly growing industry requires that scientific studies be made for its best development, and under congressional authorization such studies were begun by the department in 1920 through the Biological Survey. Improved methods have been recommended to herd owners for handling reindeer and utilizing the range, and investigations on these lines are being continued, with the reindeer experiment station of the Biological Survey at Fairbanks as a center. A study of range units is being made with the view to inaugurating a permit system of grazing allotments. Careful and continuous inspection will be required to determine whether an area is being under or over grazed.

Of the two types of reindeer in Alaskan herds, the long, rangy type is usually heavier and better for meat production. The dressed weight of a carcass averages 150 pounds, with 300 pounds as the maximum. Experiments in the development of a heavier type are being conducted on Nunivak Island through crossbreeding with caribou bulls captured in the interior of Alaska and transported to the island for the purpose.

The use of sled reindeer is recommended for herd management and other transportation uses, and studies have been made in breaking and training the animals and in feeding them on other than a lichen diet.

Reindeer have been successfully fed grain and hay with other cultivated crops, and lichens are found not to be essential to their maintenance. As a ready source of food, lichens will continue to be the chief sustenance of the herds, however, and are what make reindeer grazing possible in Alaska. Studies will be continued to determine the effect of a varied diet on meat quality.

Grazing in Alaska is tending toward permanent ranches with natural boundaries, each grazing unit having its own summer and winter ranges. Under a fixed-allotment system open herding is found more practicable than the close herding introduced by the Lapps.

Coastal, interior, and intermediate range belts have been studied with a view to establishing for each unit definite summer and winter grazing areas. As forage is likely to be trampled in wet tundras, and growth reduced on rocky areas, the carrying capacity is greater on the dry-tundra type of range.

Timbered ranges have an advantage over the treeless in that they afford shelter to herds and herders and supply fuel and materials for cabin, corral, and fence construction. On many allotments two or more herders' cabins are needed, and boundary and drift fences are considered practicable.

As regards range belts and types, the main forage cover on winter ranges consists of lichens—on the coast range with a sedge-browse subtype, and on the interior ranges a browse subtype; on summer coast ranges a sedge-browse forage predominates, and in the interior a browse-sedge-lichen type.

Lichens are seldom present in pure stand, their average proportion in the total cover on winter ranges being about 50 per cent, the remainder consisting of a varying admixture of browse, sedges, and mosses. The most abundant of the lichens are those of the genus *Cladonia*, with *Cetraria* second in importance.

To determine the reaction of lichens to grazing, quadrat studies have been begun on the range, and the results reached indicate a rapid rate of establishment of new plants after denudation, depending upon moisture, but a slow recovery to normal stand. One denuded area regained 50 per cent of its former stand in four years, and it is indicated that the normal vegetative stand, including other growth, should be reached in 7 to 10 years after denudation, but 15 to 20 years seem required to attain a normal lichen height of 4 or 5 inches, except in rocky areas, where recovery might take as long as 25 or 30 years. Such slow recovery makes evident the necessity of extinguishing and preventing range fires, of limiting the stocking of an area to its carrying capacity, and of carefully protecting winter ranges.

Winter grazing requires a greater acreage per head than summer. Yearlong, from 40 to 60 acres for one reindeer is indicated—10 or 15 for summer and 30 to 45 for winter grazing. About Norton Sound the acreage per animal is 40 to 45, and farther north 50 to 60. These figures furnish a basis for determining the future carrying capacity of definitely marked areas. The areas available to grazing in Alaska should ultimately support 3,000,000 reindeer, a third of this number on the coast section now occupied.

Full progress in the reindeer industry can come only from the adoption of better management methods, not only in range control and regulation but in herd management and provisions for transporting and marketing the meat. This involves open herding, reduction of the proportion of bulls in the herds, selection of the best stock for breeding, infusion of new blood by transferring bulls and cross breeding with native caribou, adoption of improved methods of corralling, branding, and castration, keeping sled reindeer in each herd, and providing for herd ownership on the percentage basis for increases, with one registered brand for a community herd, and for cold-storage facilities to assist in marketing.

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This bulletin is a contribution from

Bureau of Biological Survey	E. W. NELSON, *Chief.*
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